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Workshop on Integrated Crew Resource Management (CRM)

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16. Abstract

The continuing development and implementation of Crew Resource Management (CRM) training and assessment began in the late 1970's. There is interest in exploring paradigms and techniques which address an integrated, simultaneous assessment of CRM skills and the more traditional "Stick and rudder" (flight control) skills. A preliminary model for analysis and assessment in integrated CRM was developed. This paradigm, and its potential uses, were investigated by an Air Transport Association (ATA) of America focus group. The focus group was part of an ATA working group and sub-committee on Advanced Qualification Program (AQP). The workshop was designed and facilitated, and results prepared by, the Research and Development Service.

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REPORT

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I. INTRODUCTION

A. An Overview of Crew Resource Management (CRM) Integration

The integration, and assessment, of Crew Resource Management (CRM) and flight control skills has received considerable attention--and, a fair share of concern and skepticism--over the past few years. As one response, the ATA formed an air carrier/FAA/academe working group to deal with this, and other CRM issues, in 1990.

The main issues in doing a simultaneous and integrated assessment of CRM and flight control performance revolve around:

1. Identifying, developing and validating the observable/rateable performance behaviors that define CRM.

2. Developing a behaviorally-anchored scale, or set of scales by which to assess these CRM performance behaviors. There is also the problem of developing a set of crew performance behaviors for the technical flight control skills similar in format to the CRM performance markers; this set would then be used in any attempt at the integration with the CRM behaviors.

3. Developing an analytic paradigm which could both identify and demonstrate (*what* were) the CRM performance behaviors embedded in, and intrinsic to, the flight control skills necessary for safe, efficient missions. Such a paradigm must be able to analytically show *where* the integration of CRM and flight control skills occurred, i.e. *where* during the accomplishment of *which* maneuvers/tasks/sub-tasks. The model should be capable of dealing, on a specific level, not only with different aircraft types, but also with different environmental conditions and with the different SOP's in use with the different air carriers.

4. Finally, any model or paradigm developed needed to be both operationally-oriented and very accurate. This is because any CRM integration paradigm would immediately confront a mind-set that has evolved in the development and "selling" of CRM and from the idea of the existence of "soft" (as opposed to "hard") piloting skills.

Historically, much of the original impetus for the formalized CRM research and development came from a series of commercial aviation accidents. In these well-publicized, fatal mishaps,

neither aircraft malfunction nor maintenance were the causal factor(s). Rather, communication, command, leadership, and other psycho-social factors were called out as the real problems.

There were several people who had recognized these issues prior to the string of accidents and who then stepped forward. People such as John Lauber, Clay Foushee and Bob Helmreich began the research and development (or, in some cases, continued their existing work) which brought forth much of initial CRM. However, almost from its inception, CRM was seen as somewhat of a stand-alone and/or a "fix" for a certain type of accident. Since many of the people who came into the field next were from the discipline of organizational development, there also grew a perception that CRM was involved only with soft, squishy "crow like a rooster" activities and skills. Lastly, in an effort to encourage the air carriers to give CRM training and to encourage line pilots to take this training in a non-jeopardy context, the FAA began to grant a recurrency waiver if CRM training was taken. This action by the FAA had the additional effect of reinforcing a view that CRM training was a separate, stand-alone activity.

In fact, and in too many places, CRM indeed *was* a stand-alone piece of training with insufficient, or no effective input from the pilot community in development and delivery--and, with little, or no effort to relate CRM to traditional flying skills. It is easy to see how a mind-set came into place which incorporated all of these data.

Still, many pilots and researchers with flying experience knew, almost intuitively, that CRM-type skills were part and parcel of what good aviators *did*, and had always done and taught. As time went on and CRM grew and evolved, a view that the CRM skills had mistakenly and artificially been separated from the flight control skills also began to grow. By the early 1990s, with on-going research and development in CRM and the FAA's Special Federal Aviation Regulation (SFAR) on Advanced Qualification Programs (AQP) for aircrew providing impetus, CRM integration efforts began in earnest.

Issues I.A.1 and I.A.2 above have been extensively worked by Dr. Robert Helmreich, in conjunction with several major air carriers. At this time, he has developed a complete set of flightcrew CRM performance markers (he terms them "CRM behavioral markers") with behaviorally-anchored rating scales. In a NASA/FAA/University of Texas project, Helmreich has worked with several air carriers on research which involves the use of these markers in Line-Oriented Flight Training (LOFT).

In 1991, Captain Kevin Smith (United AirLines) and Jan Demuth (FAA Flight Standards) developed an initial set of performance markers for the Technical/Flight Control skills. Both the CRM and the Technical sets of markers were used in the next step of CRM Integration: the attempt

at developing an analytic paradigm (i.e. issue I.A.3). Kevin Smith created the framework for a model which *does* demonstrate that the CRM human factors skills and the Technical/Flight Control skills are interrelated, interdependent, and often simultaneous in execution--that, for safe and efficient flight, CRM is integral to flight control, and vice-versa. This model is called the Mission Performance Model (MPM).

Captain Smith, a member of the ATA committee on CRM, then worked with Bob Helmreich, Jan Demuth and Ron Lofaro to extend, articulate and apply the MPM to actual flight maneuvers, such as an engine out at V1, with a turn procedure required by the terrain. Concomitant with this effort, the ATA CRM group was working on a major revision to the FAA's 1989 Advisory Circular on CRM (# 120-51). As several key players on the MPM were also involved with drafting portions of the CRM Advisory, there was intense cross-fertilization, to the benefit of both efforts. The revised Advisory Circular is now in the process of final review/changes by the industry after which it enters the FAA approval process. The possible publication date is mid 1992.

B. Brief History of the Workshop

In June/July of 1991, Ron Lofaro and Kevin Smith began to see some need for a select group of experts to be convened and charged with several tasks--not the least of which would be an in-depth exploration of the MPM. At several ATA working group and sub-committee meetings (Washington, Austin) during late 1991, the idea of a "select team" workshop on CRM Integration and the MPM was brought forward. Many people expressed interest and indicated their availability as workshop participants. Dr. Lofaro volunteered his services as a designer/facilitator and the facilities of MiTech, Inc., in Washington, D.C.

The workshop was conceived of as having two phases: in Phase I, potential participants would be given reading materials and assignments as a preparation for a workshop; Phase II was to be the actual 2½ day workshop. The Phase I reading materials would contain discussions and explanations on CRM Integration and the MPM, "broad-brush" Phase II objectives, a tentative list of participants for Phase II, and the time-frame (19-21 November).

The Phase I materials were prepared as a booklet, coordinated and sent to the prospective Phase II participants. Incorporated into this Phase I booklet were the latest drafts of both the CRM Advisory and of the CRM and Technical crew performance behavioral markers. The Phase II workshop, and all materials prepared prior to, and for it, are the content matter of this report.

II. THE WORKSHOP

A. Participant Profile

There were six major air carrier line pilots, five of whom were also training program managers/directors--usually in CRM or AQP.

There were two ISD experts, one from the Naval Post Graduate School's Aviation Safety branch and one from the FAA's Flight Standards' AQP organization, as well as the Chief Pilot (Flight Training) of The Boeing Company. There was an FAA research psychologist who functioned as the workshop's designer and facilitator. Additionally, Capt. Kevin Smith of UAL presented and stayed for all of Day I, and Mr. Jan Demuth, FAA Flight Standards' CRM Coordinator, was there for Day I and all of the half-day on Day III.

The participating pilots averaged 15 years as a pilot with their current organization (ranging from 4 to 25 years), and held qualifications in an average of 3 aircraft (see Appendix F).

B. Procedures/Process and Materials

In early October, 1991, each participant received a Phase I Booklet (See Appendix A). This package gave a brief background of CRM integration, an overview of the MPM, the latest draft of the (revised) FAA Advisory Circular on CRM and the crew performance markers--CRM and Technical--with rating scales. This was a 56-page booklet.

NOTE: For this report, we have removed the draft version (Draft 2.5) of the CRM Advisory Circular which was a part of the Phase I booklet. Rather, we have included the latest draft (Version 3.4) as Appendix C.

The participants were asked to read and to familiarize themselves with all of the Phase I materials and to complete Objectives IA and IB individually.

Objective I:

A. To examine the behavioral markers--both CRM and Technical.

B. To examine the two behaviorally anchored rating scale(s) for the above-- *both of these can be (initially and individually) a "homework" part of Phase I; the finalization via group work we will do at the workshop.*

Objective II: To complete the mission performance model by:

A1. Developing a criticality scale/rating methodology (or, other method) for the identification and criticality-rating of the sub-tasks/elements on any mission task.

A2. ALTERNATIVELY, comparing/contrasting/modifying/integrating (--whatever) the MPM and Figure 2 in the latest draft of the CRM Advisory. (Remainder of objective is somewhat the same.)

B. Exercise the model--use 3 tasks per phase of flight (normal; abnormal/ emergency; "other") as an initial review/critique and modification; as a check on the completeness of the task decomposition via criticality-rating (or, whatever other method was used).

C. Re-exercise the model to check any mods that were made (--same format as in II.B, IV..5 as to the number of tasks, etc.).

D. Identify/articulate any rules and algorithms embedded in the model.

E. Develop scales/rules for evaluating the existence/strength of CRM and technical skill interrelationships--task/sub-task level.

Objective III: To identify/examine the potential uses of the model--with attention to:

A. Aircrew CRM Training development;

B. LOFT scenario development and/or evaluation;

C. Instructor Pilot/Evaluator training;

D. CRM/LOFT evaluation.

This Phase I "homework assignment" was in preparation for the Phase II workshop, which was also referred to in the Phase I booklet.

During the next four weeks, conversations occurred between Ron Lofaro and all the participants. These telephone talks covered a variety of questions and concerns on the Phase II effort.

Day I:

On November 19, 1991, the Phase II workshop was convened at 0900 at the Headquarters of MiTech, Inc., in Washington, DC. This company has a support contract with the FAA/ARD-200 and their headquarters were chosen because of the facilities available, ease of travel (they are one block away from the Metro stop at Union Station), and to provide a neutral atmosphere for the workshop. Ron LoFaro welcomed the participants, spoke on the goals of the workshop, then on administrative and other details, and distributed the Phase II booklet (see Appendix B) and the latest draft of the FAA CRM Advisory Circular (see Appendix C).

Jan Demuth offered a welcome on behalf of himself and his (Flight Standards) organization. He then gave some views on the MPM. Included in these were: (1) his hopes that the workshop was not construed as a *sub rosa* effort to make the MPM an industry standard, use of the MPM in CRM or AQP was not "required;" (2) the MPM should be seen as a jumping-off point to many different training and assessment endeavors; (3) the MPM could logically and profitably be looked at as part of larger, and not yet developed model(s). Mr. Demuth then offered some insights on the MPM, as it now exists, in relation to AQP. He did want an awareness that the MPM, is not, by itself, a front-end analysis (FEA) tool as it does not "fold in" a condition set. In that sense, the MPM (as is) should not be used to write critical performance objectives. Finally, Jan offered his insight that the MPM, as it is developed, would only be able to deliver its full value if it were computerized/automated. He then, again, spoke of the MPM as a starting point and one which holds great promise.

During the next five hours, Captains Kevin Smith and Bill Hamman of United Air Lines gave lengthy expository presentations on the MPM and CRM Integration. Captain Hamman also showed a 45-minute videotape of a portion of a LOFT scenario. In this video, the LAX Civit profile descent was being flown, while the crew was distracted by a cabin problem. The video was accompanied by an analytic decomposition of the tasks and sub-tasks required to successfully perform this profile. This analysis had been performed using the MPM. This tape demonstrated that the model *did* capture all the critical tasks required to successfully perform the maneuvers as well as providing an assessment schema which could differentiate levels of crew CRM and Technical performances. The video, with the handout, seemed to show a *prima facia* validity for the MPM.

There were consensual modifications made to Objectives I and II. In Objective 1, step A, it was decided to look, not only at the markers themselves, but also at the categories and clusters to which they belong. It also was decided to discuss and critique the (latest) draft version of the FAA Advisory Circular on CRM which was provided by Jan Demuth on Day I.

In Objective II, step A1 (a criticality/rating scale), it was decided to discuss the concept, rationale and use for the use of this type of scale in the identification of the sub-tasks which are critical to a flight task/maneuver. Objective II, step A2, was scrubbed altogether. In Objective II, the exercising of the model and beyond (steps B through E) was not done. There were several reasons, the major one being a feeling that not until Day 1 had the MPM begun to be truly understood by the workshop participants. The MPM, or portions of it, had been briefed to the majority of the workshop participants at ATA meetings in May, September and November 1991. However, there was little or no time for full discussion at these ATA meetings as the agendas were full and required that Q and A were held down considerably.

During Day I, both Kevin Smith and Bill Hamman presented the MPM and its application in great detail, with full opportunity for questions, explanations, discussion. Even for those who had felt familiar with the model, these presentations incorporated new work done on the model (after the last ATA sessions and prior to the workshop) which lead to some reflection and re-thinking on the MPM. Hard copies of these briefings are at Appendix A and, along with the Phase I materials on the MPM, should provide insight and understanding to the reader as they did to the participants.

During the last hour of Day I, Ron Lofaro led a detailed discussion on the workshop objectives as well as the procedures for accomplishing them. An 0830 start-time for Days II and III was agreed on and the participants were requested to review their "homework" assignment.

Day II:

A brief period of time was spent by Ron Lofaro in synopsizing Day I and in making team assignments. There were two "work-teams" of five members each; the entire group was considered as the "intact" team. Objectives I, A&B, were separately worked on by the working groups. After lunch, Dr. Lofaro convened the intact group, both work groups presented their findings and a discussion ensued which led to a consensus as to these objectives.

NOTE: The original planning of the workshop was to use Ron Lofaro's "modified small group Delphi" paradigm* to do the objectives. However, due to the length of the Day I presentations and discussion, time constraints did not allow for use of all paradigm components, nor for the successive iterations needed to achieve all criteria of the paradigm. On the other hand, the workshop was able to use many of the paradigm's processes and Ron Lofaro was available to facilitate the entire effort. As was shown in the participants response satisfaction questionnaires, they felt very comfortable with both the process and the results. (See Appendix F.)

The remainder of Day II saw a modification to the schedule and objectives in that the group immediately decided they wanted to do a final critique of the Draft CRM Advisory Circular and then, quickly, and as an intact group, deal with Objective III. This was accomplished and the group broke at 1600.

Day III:

This was a half-day session and began at 0800. Jan Demuth provided a sounding board for a short report-out on the Day II activities. Jan also made a short, informal presentation dealing with the positive roles that the FAA sees the revised CRM advisory circular as playing. Mr. Demuth clarified some of the issues and "realities" as to the current non-use of CRM in the qualification and certification of airmen--and the difference between mandated CRM and mandated CRM **evaluation**, especially as regards to developing standards which are not currently in existence. A lively, intact group discussion followed on CRM assessment, the Draft Advisory on CRM, and on different uses for the MPM. A synopsis of Mr. Demuth's main points is in Appendix E. These are significant and bear reading, as they relate to CRM evaluation, possible future NPRM, and the revised CRM Advisory Circular.

III. RESULTS

A. Objective I, Steps A and B

General: The adequacy and accuracy of the categories and clusters within which the markers are grouped was questioned. The markers are the building blocks, and any category or

* "A Small-Group Delphi Paradigm" (Lofaro, R.J., 1992). Human Factors Society *Bulletin*, Vol. 35, No. 2; "Exploratory R&D: Army Aviation Candidate Classification by Specific Helicopter" (Lofaro, R.J. and Intano, G.P., 1989). *Proceedings* of 5th International Aviation Psychologist Symposium.

cluster reorganization will cause the markers either to migrate or to be altered. Several airlines indicated that they view the markers, as now written, as potential research tools. However, they also indicated that, for operational analyses and/or to capture the specific performance behaviors for a specific airline SOP, the markers are not suitable. The markers are a first (and important) step toward removing some ambiguity about flightcrew CRM and Technical performance, and are one focus that can be used. However, they have definite limitations; for example, in "conflict resolution", the markers are poor. The view was expressed that the markers do not apply uniformly across all flightcrew actions and decisions. The bottom line here is that: (1) the existing markers, categories and clusters are valuable and may have importance as a research tool; (2) the markers, categories and clusters must be open to change, to include adding new ones or deleting existing ones; and, (3) any set of markers, categories or clusters that is to be used in the operational area--for flightcrew assessment, LOFT development, curriculum development--should be developed, analyzed and evaluated by an airline prior to use.

The 5 point Likert-like scale used with the markers was also critiqued. This scale was seen as viable *if* the markers were used as a research tool. For operational use, a "yes/no" or a 1-2-3 type assessment scale was considered superior. However, the discussion did bring out that, while it may be possible to use a five-point evaluation scale, there was considerable disagreement of how to (or, if there even was a reasonability possibility of) differentiate "3s"; "4s" and "5s" on such a scale.

Specific: A set of automation management markers must be defined and a rationale developed for where they go. In doing this, there must be a realization that this marker set may go into two (or more) places and that, perhaps, this could be an accurate representation of operational reality.

1. A.3 The consensus was that the category title, "crew self-critique" carries negative connotations. The preferred term (for critique) would be feedback; this implies a two-way communication, a dialogue, an effort at improvement using the feedback.

2. C.8; 1 through 7 This set of markers was seen as redundant, "wordy," and has some confusion of outcomes and performance.

3. C.7; 2 A marker must be developed and put in which calls out "guard against routine--engendered complacency."

NOTE: At this point, a consensus was that all the markers could be critiqued, at a great cost of time. Since the general discussion of the markers had established that they could and should be

examined and altered, it was decided to go no further with critiques of individual markers. In sum, while the group initially did not feel the need to go through the markers one by one, after some four specifics were brought forward, the discussion reverted to some general issues after which it was felt further specific critique was not called for, or efficient.

B. Objective II, Part 1A

Critique and Comments on Version 2.5 of the Draft CRM Advisory Circular: This discussion was a strong one and, in some part, prompted by remarks by FAA personnel (at Northwest Airline's "Industry CRM Workshop" on November 13, 1991, in Minneapolis) that a Notice of Proposed Rule Making (NPRM) on CRM was foreseen for Spring 1992. This engendered new interest in the entire draft CRM Advisory, since it would form the basis for the NPRM. The remark also evoked strong reactions about the issues involved in any attempt at CRM evaluation.

The discussion of the draft Advisory Circular had two components. In the first, the two figures used (Figures 1 and 2) were discussed. In the second, CRM evaluation was thrashed out.

The consensus as to Figures 1 and 2 was that the CRM Integration Model presented in these two figures had some problems. The following suggestions and concerns were brought out:

1. A better articulated rationale for Figure 2 is needed.

2. Figure 2 should be used without the categories/clusters. These categories/clusters can be placed in an appendix. Along with this change, put the crew performance behavioral markers (CRM and Technical) in an appendix.

3. The content validity of the model has not been established.

4. Neither Figure 1 nor 2, nor the Advisory Circular itself brought out the importance of criticality-rating, allocation, or prioritization of skills and tasks as to their necessity, and as to the possible changes in the figures which can result by doing such analysis.

5. Finally, and in a discussion which seemed to capture all of the above, the view was brought out that there are (many) alternate Figures 1 and 2 possible--dependent on an airline SOPs, analyses, operational emphases. At this point, Jon Tovani, of Delta Air Lines, shared with the group an alternate to Figure 2 which had been developed at Delta. The group agreed that different models could capture CRM Integration and

that, perhaps, a statement to that effect needed to be in the CRM advisory or, a similar statement that Figure 1 and 2 show one useful way of conceptualizing CRM Integration.

The advisory also should encourage each airline to develop a CRM Integration model which was particularized to "fit" its goals and operations--and, to fit the CRM Integration Model into the issue of (eventual) flightcrew evaluation/assessment.

NOTE: There is now (February 1992) a draft revision of the Advisory Circular that obviates some of the preceding section. However, in order not to lose some historically valuable discussions and consensus, the section has been left as written in December 1991. Appendix C contains the latest draft of the advisory.

CRM Evaluation: There were considerable concerns with doing this, and particular questions. No resolution was achieved on the questions. A major concern was a feeling that CRM evaluation, using the current sets of CRM and Technical Performance markers cannot be done--especially if such an evaluation meant using each and every marker, for each and every evaluation. The major set of questions revolved around:

1. Are CRM skills eventually to be "bustable"? (versus Part 121, Appendix F)

2. Will a P.C./checkride give "equal" weight to the CRM skills? (A view was expressed that the draft CRM Advisory Circular *seemed* to say so).

The participants concurred that the industry is not at a point to evaluate CRM quantitatively. All of the participants, except one air carrier training officer, thought that qualitative evaluation, of a "SAT/UNSAT" type, may be possible. A concern arises in giving *and justifying* a CRM "UNSAT" if all technical skills are rated acceptable. However, this consensus was tempered by two factors:

1. There is an acceptance that *now* is the time for the airline industry to think about, and begin, efforts in CRM assessments. Some air carriers are already involved in such efforts, under the "no jeopardy" concept, in LOFT.

2. In some airlines CRM assessment exists--with SAT/UNSAT based on three-point scales. There was some concern that what one airline finds acceptable or desirable as assessment might be forced as a "standard" on other air carriers.

NOTE: Several participants reported that their airline, at present, is grading CRM indirectly during a check flight. Poor CRM performance usually results in poor technical performance. However, the UNSAT is attributed to poor technical performance rather than CRM shortfalls.

C. Objective III

This objective resulted in finding six potential applications for the MPM. Caveats made by the intact group were that the MPM, as it exists, still needs further development, and particularization to each airline's SOP's goals. The six potential uses were:

1. Since the MPM is seen to be generalizable to the "expanded crew" concept, it has use in developing and integrating CRM for maintenance, flight attendant and dispatch functions.

2. Since the MPM demonstrates and "defines" CRM Integration and the application of CRM skills to particular flight maneuvers, the MPM lends itself to LOFT (or other) scenario development. The MPM could be used as a template for overlay onto an existing scenario, and/or as an initiator for the development of a scenario. In these ways, both the training personnel and the SME pilots involved in LOFT development would use the MPM.

3. The MPM could be used in a rough Front End Analysis (FEA) of CRM skills to determine:

   a. What are the CRM skills necessary, in and of themselves, for a safe flight?

   b. What, *in toto*, goes into the safe movement of an aircraft from point A to point B?

4. The MPM could provide a focus for the development/delivery of Instructor Evaluator training--"a train the trainer" tool.

5. Similar to III.C.3, the MPM could be used in LOFT development to calibrate and/or evaluate the scenario(s).

6. Finally, and somewhat akin to III.C.3, the MPM could be used to identify and demonstrate *what* CRM skills must be embedded in pilot skill training--and, *where* in the training cycle this should occur.

NOTE: Jan Demuth, on Day III, suggested that another use of the MPM could be the validation, at the sub-task level, of any/all of the crew performance markers. He also suggested that such a validation could occur in the exercise of the MPM.

D. Objective II (all parts except 1A)

This was not accomplished. The Discussion Section (below) fully explores the reasons for this lack. However, the uses of the MPM are being explored and developed at United Airlines, and it is hoped that one result of the workshop will be its exploration, particularization, and use by other air carriers.

IV. SUMMARY DISCUSSION

The workshop plainly did not accomplish a major objective--Objective II, the exercising, critiquing, clarifying and finalizing of the MPM. One of the reasons for this has been mentioned prior, that the MPM was not completely understood or fully discussed prior to the workshop. The major reason is there simply was not sufficient time for this Objective, even if all of Days II and III could have been allotted to it. This error lies with the designer/facilitator--and can be attributed to his aggressive optimism coupled with no yardstick by which to estimate this task, i.e., no one had attempted any of the components of Objective II, except Kevin Smith--and Captain Smith's experiences were never "timed." However, this lack of opportunity to begin to deal with Objective II was offset, to some degree, by the best, most complete, most discussed and probed dual presentations on the MPM that had yet occurred. The presentations by Kevin Smith and Bill Hamman had two results:

1. While the MPM had been gone over and looked at by others, their efforts were all-too-often time-constrained; colored by other, similar efforts they were engaged in for their various airlines; hampered because they had not had the fullness of detail and the requisite give-and-take of a "complete" question and answer session with Kevin Smith prior to the workshop. The workshop ameliorated this, to some degree.

2. The presentations at the workshop made the various participants comfortable enough with *their* knowledge of the MPM that they expressed a willingness to work the model, at their respective airlines. This was the first expression of such an intention/possible use of the model by other than UAL. There is the possibility of a future workshop. Such an effort could be coupled with agenda time at ATA working group sessions where people would report on their efforts, problems and solutions while using the MPM--or some modification thereof.

In retrospect, it was probably premature to have committed to Objective II. However, as 1992 unfolds, it is now reasonable to expect that some air carriers will be involved in on-going *work*, and the reporting/sharing of it, that relates to CRM Integration and the MPM.

The workshop plainly did accomplish several things--not the least of which was a continuation of the non-critical, open, sharing of concerns, issues and current efforts by the airlines which participated. The Northwest, one-day, Industry Workshop (Minneapolis; Nov. 14, 1991) had set a tone of trust through the non-judgmental presentations and discussions in CRM concerns, issues, efforts by the major carriers with the FAA and NTSB in attendance. That is rare. The workshop, in some ways, built on and continued this Northwest-hosted effort.

The workshop also demonstrated that there is diversity within a shared goal and some shared tools. Each airline indicated that they were looking at using, and *modifying* for their operations and in light of their analyses, the behavioral markers and the CRM/Technical schemes laid out in the draft Advisory Circular. Further, some of the criticisms and modifications which came up at the workshop not only made sense, but also will become part of current and future airline work by virtue of being expressed, shared and being a part of this report.

V. RECOMMENDATIONS

NOTE: These recommendations are presented unchanged as received from the participants following their review of the draft of this report.

1. Work should continue on CRM Integration and the MPM.

2. Another workshop of approximately the same length should take place during the first half of 1992 to continue work in this area. The goal of this new workshop should be to complete Objective II.

   a. Workshop participants should be polled to determine whether or not another workshop is required or desired.

3. Evaluate the MPM and other alternatives, thus:

   Establish a specific task for each airline to use with the model or representative. Examples of tasks could be specific as a potential for windshear on takeoff or could be a complete LOFT from A to B. Have each airline use their SME group to use the

CRM integration model. After this is completed, a joint conference should be held to compare the key factors of CRM for this particular task. These results would then be analyzed to validate the sensitivity, usefulness and accuracy of the model to establish the CRM elements of aircraft operations. This type of approach would also add valuable information to assist other subcommittees of the ATA, i.e., LOFT subgroup.

4. A formal acknowledgment is made of the efforts/time spent by Kevin Smith in the creating and developing of the MPM for the good of the Aviation Industry.

VI. ALTERNATE VIEWPOINT

One air carrier indicated, in their review of the draft of this report, that they wished to express certain reservations and/or disagreements with portions of the draft report. In order to make this report as complete and comprehensive as possible, their comments are presented below:

A. 1. The MPM is seen as a type of task analysis tool that, to its credit, focuses on both technical and interactive components of crew performance.

2. The MPM seems to validate what has been explained by Helmreich's behavioral markers and other airlines' own ongoing task analysis for AQP.

B. The MPM implies an evaluative strategy that is arbitrary and incomplete:

1. The MPM is arbitrary in its assignment of CRM skills to specific tasks in a scenario.

2. The MPM is incomplete in that it lacks specific criteria for a scaled grading scheme.

C. Continuing work on the MPM should focus on empirically validating the assignment of behavioral markers to tasks. This validation could use data from actual crew performance observations; e.g., LOFT observations.

APPENDIX A:

Edited Version of Phase I Materials

AIR TRANSPORT ASSOCIATION (ATA) OF AMERICA

WORKING GROUP EFFORT

ON INTEGRATED

CREW RESOURCE MANAGEMENT (CRM)

PHASE I

The ATA Sub Committee
on CRM Integration

Phase I

Table of Contents

I. CREW RESOURCE MANAGEMENT (CRM)

A. History

During the late 1970s and through much of the '80s, major air carriers experienced a number of fatal accidents where the causal factors were not part malfunctions, flight control errors, lack of skills, incorrect procedures, or any of the traditional aviation accident categories. Rather, there were causal chains of events/ actions/inactions where the common threads were communication problems and a lack of cohesive, crew-level planning and decision-making. From many accident (and operations) analytic studies came the realization that a new element was necessary in flightcrew preparation. As human factors experts began to look more and more at the group/interactive aspects of flightcrew functioning, it became apparent that many accidents and incidents could be attributed to a lack of CRM-type training and skills; that human performance errors were linked, on the flightdeck, to factors that had previously not been recognized, identified or investigated. Both United and KLM took the lead in developing what, at that time, was termed Cockpit Resource Management training.

Dr. John Lauber and Dr. Clay Foushee of NASA-Ames led the way in bringing CRM to the attention of the aviation community. Along with Dr. Robert Helmreich of the University of Texas they began to hammer out the basic CRM concepts and theory while doing research on crew performance and crew skills.

The late '80s brought some measure of agreement in aviation that CRM training had the potential to affect safety of flight and crew performance positively. The FAA, in recognition of this, would grant a waiver on recurrency, if the airline used CRM Training.

A thorny issue, officially recognized at a major CRM workshop (1986), was the evaluation of CRM--the issues were many and included not only how, but also why, and what criteria were to be used, as well as the individual in a crew versus the crew level of performance. There are still issues to be resolved and there are still disagreements. However, Dr. Helmreich, in a joint NASA/FAA project, and others continue to research the issues and to develop new training, as well as evaluation methods. These include the Line/LOFT Checklist (LLC); CRM training participant surveys; CRM participant attitudes and personality factors measures as related to performance differences across/within airlines and their fleets.

The next major shift came in the very late 1980s and early 1990s. This was occasioned by an FAA effort to establish a Federal Air Regulation (FAR) which would allow and encourage airlines to develop their own alternative training programs/flightcrew training programs which followed certain FAA guidelines, but whose establishment was voluntary; programs which led to alternative methods of airman qualification, certification and recurrency. This regulation (SFAR 58), published in October 1990, is called the Advanced Qualification Program. In any innovative training program that an air carrier proposes under this SFAR, CRM training is mandated and Line Oriented Flight

Training/Line Oriented Simulation (LOFT/LOS) is encouraged. This is in line with the fact that many existing air carrier CRM programs do include a flight simulator scenario (a LOFT) to be critiqued as a "final exercise".

This SFAR, while mandating CRM in any Advanced Qualifications Program (AQP) curriculum, also mandated that it be evaluated--and evaluated in a way to demonstrate proficiency. In fact, all AQP's must be proficiency-based, and the proficiencies must be validated. At this point, the prior issues of CRM evaluation had to be resolved. A first step was the development, by Bob Helmreich, of Behavioral Markers; behaviors which needed to be present as indicators of the possession of the major CRM component skills. These markers also had 5 point evaluation scales to measure the skill-level of each CRM component. These are called "Crew Performance Markers" and have been expanded by Kevin Smith to include the Technical/Flight Control components.

All of this has lead to the initial work, by Bob Helmreich, Kevin Smith and Jan Demuth, on a CRM integration model. This model integrates the stick and rudder skills/knowledge needed for flight control with CRM skills and knowledge. The model, to be covered more fully in Section II, is called the (Flightcrew) Mission Performance Model (MPM). It focusses on the integrated crew functions necessary and critical for safe and effective completion of any flight.

B. Phase I and II Purpose

The mission performance model is in its initial stages of development. What needs to be done is to complete it, i.e., add to it, exercise it, modify it, "finalize" it. In doing this, we see a series of steps, or objectives:

1. Apply existing form of the model for familiarity
2. Ascertain what needs to be added/subtracted/changed
3. Re-apply model--over different phases of flight--and ensure that it can handle all conditions (e.g., emergencies) and procedures
4. Ascertain if the model can deal differentially with different fleets and company SOP's
5. "Find" all algorithms or rules embedded in the model
6. Identify/develop uses for the model--emphasizing LOS design and evaluation and aircrew performance behaviors

What we have given you here is obviously a broad-brush look. There will be a more specific version of these (working) objectives given to you at the Phase II workshop.

II. THE MISSION PERFORMANCE MODEL

A. Overview

The purpose here is not to make you an expert in the model--it is still developmental--but, rather, to acquaint you with its rationale and provide a few examples. In this way, we hope that you will come to our Special Team Workshop with definite reactions and ideas. The model is based on the concepts that:

1. Flying is an integrated, mission-oriented activity which must be evaluated as such.
2. The crew's performance is not adequately captured by totaling the sum of the component tasks/sub-tasks/elements. The focus must be on crew function--usually at the task and critical sub-task levels.
3. Flight proficiency skills/knowledge are interwoven, interdependent, and necessarily interact with the CRM skills/knowledge differentially across tasks and conditions. These interactions can be specified by a matrix-type crew mission performance model using the tasks which comprise a mission/leg.
4. The model can capture these interactions; can be sensitive to changes in both task and mission, i.e., show that, for different tasks and conditions, both the technical [flight] proficiency skills and the CRM skills, and their interactions, will vary. This is an indication that the model has a measure of discriminatory power, or "sensitivity" to changes in task and conditions.

5. Helmreich's "Behavioral Markers" can adequately delineate CRM skills and provide a basis for the CRM-specific Flightcrew Mission Performance Model.
6. The bases for the technical proficiency evaluation currently exist, in a behavioral marker-type format, and Scales exist, or can be developed, for evaluation of all these proficiencies.

B. Discussion and Example of MPM

The Mission Performance Model has embedded within it the concept of functions. It is proposed that the model, as constructed, represents all significant functions necessary for the successful completion of an air transport mission.

This model views crew performance as consisting of system level functions which represent the mechanisms that are used to perform a mission activity. The importance of a model that is founded on a set of systems level functions cannot be overstated. Moreover, the model delineates crew performance at a level of abstraction that is significantly different than the current descriptions of individual performance.

For individuals, performance has often been seen as a series of discrete tasks, where each task was further decomposed to reveal a set of subtasks combined with the

requisite knowledge and skills necessary for subtask completion. For many applications, such as aircrew training, this produces a large collection of task, knowledge and skill data.

In most traditional pilot or crew training programs, these are taught individually as isolated knowledge components. Consequently, the trainee is left with the responsibility of combining these isolated knowledge components into integrated wholes (Merrill, 1989).

The linear decomposition of individual tasks does not address integrated functioning nor does it reveal how tightly coupled teams (flight crews) perform, thus an analytical process other than the traditional task analysis approach is considered necessary. We, therefore, have chosen the Functional Modeling approach.

The MPM consists of a set of functions that can be activated by inserting an instance/example; in other words, asking the function to specify/describe a particular activity or situation in the mission. If a particular function, e.g. "Workload Management," was asked to "spin out" the components of a particular mission activity, such as take off with an engine failure at V_1, then the function should be able to organize, sequence, distribute, and coordinate key crew actions so that a successful outcome could be assured.

This workload management function, then, can be viewed as a generic performance statement that

1. Can be applied to many mission activities/situations, and
2. Can be activated for the application to, and specification of, any one of these activities/situations.

[Note: Any case in which the Mission Performance Model is activated in order to accomplish a particular mission activity shall be termed "instantiation." Instantiation means the function has been activated, or made particular, by using values/activities in place of variables.]

To return to our previous example of workload management during a take off activity with engine failure at V_1, we see that:

(1) The workload function is being asked to deal with the "effective" management of workload during this critical flight maneuver.

(2) Once targeted, the specifics of the critical flight maneuver are embedded within the function.

(3) The evaluation of this function, with respect to the demands being placed on it during this critical flight maneuver, gives us insight into the robustness of the function.

We have been using the term "Mission Performance Model" up to this point, and before we proceed with "CRM Integration," a few words about the concept of a model are in order.

The Mission Performance Model is one which can specify the components of flightcrew "effectiveness" (effective performance). That the model represents effectiveness is important to understand since, if the crew is really engaging in the set of functions that are germane/linked to the problem at hand, and if these functions are the prerequisites for a successful outcome, then effectiveness has been demonstrated.

Similarly, the model is prescriptive--it prescribes what needs to be accomplished for the crew to perform effectively. For example, we can specify, during the LOFT design process, what are very likely to be the necessary crew behaviors.

C. The Concept of CRM Integration

The first step in the analytic process of "CRM Integration" is to note that for a particular mission activity, an appropriate set of technical **and** human factor functions will need to be performed, and will need to be performed together. For example, if one were to focus on the vertical navigation components of the initial approach phase of a mission, both the workload management and situation assessment functions come into play in conjunction with the technical-based vertical navigation function. Further, all three of these functions can be shown to interact. This notion of interaction will be explored later, but, for now, we want to show that very often we will have both human factors and technical functions working together to perform a particular mission activity.

D. The Demonstration of CRM Integration

The CRM integration process is demonstrated by creating a matrix array where the left column is any mission activity or situation (i.e., the flight tasks involved), and the top row of the matrix specifies both the CRM and flight Performance Markers in the description of the Mission Performance Model (MPM). [These markers can be found in the Draft FAA CRM Advisory Circular, Appendix D.] Once the matrix is set up, relationships between various activities and functions can be identified. These are shown in the row/column intersections. These intersections are where the functions come into play to accomplish a particular flight task.

There are three large **clusters** under which the Performance markers for the Cognitive and Interpersonal (C&I) CRM are gathered:

1. Team Formation and Management Tasks (Cluster A);
2. Communication and Decision Tasks (Cluster B); and,
3. Situational Awareness and Workload Management Tasks (Cluster C).

Each of these clusters is further broken out into categories, which comprise the critical tasks that are performed in each cluster. These categories are given single or double digit numbers as identifiers--such as, under the Communication Process and Decision Tasks Cluster, we will find four categories, e.g., Briefing, Crew Self-Critique. The categories, under each cluster, are finally broken out into descriptive "Performance markers." These Performance markers delineate the actions and behaviors which make up a category. There are usually two to seven Performance markers (for example, "Identifies potential problems, such as WX, delays and abnormal systems ops," or "sets expectations for how deviations from SOP are to be handled") defined for each category.

Further, each Performance marker, in each category, in each Cluster, then is evaluated on a five-point, performance-anchored, scale--from "poor performance, significantly below expectations," through "exceptional performance, significantly above standard."

Using an operational-type analysis, the CRM and flight skills are identified, as to which skills are brought into play across the crew's functioning. The matrix is thus completed (see Figure 1).

CR	6.1. Perform Initial Approach	Communications Process & Decision Behavior	Workload Management & Situation Awareness	Team Building & Maintenance	Operational Integrity	Flight Maneuvers & Attitude Control	Propulsion/ L/D/Drag Control	Systems Operation	Malfunction Warning & Reconfiguration
72.5	6.1.1. Assess Environmental Factors	A23 A24	6112 C71 C74		6112				
75.75	6.1.2. Assess Approach Continuation : Decision Factors	612 A42 A43 A44 A45		B53	6124 D1 D2				
	6.1.3. Reconfigure/ Check Systems		C71					613 C1 C3	6131 III
	6.1.4. Reconfigure/ Check Aircraft		C71		6143 614371 D4		6141 F1 F2		
67.1	6.1.5. Fly Lateral Track		615 6155 C77 C88 C810	B54	6152 6157 D2	61521 6153 6154 E1 E2 E3 E5			
74.0	6.1.6. Fly Vertical Profile		616 C77 C88 C810	B54	6161 D2	6162 E1 E2 E4 E5 E6	6163 61632 F2		
	6.1.7. Perform Communications	617 A25 A41							

Figure 1

Several things must be noted: Not every row/column intersection in the matrix will have either CRM and/or flight skills in it.

Not every row/column intersection which has flight skills will have CRM skills--and vice-versa. However, each time a row/column intersection has both flight control and CRM skills, then that is an indication of the fact that both sets of these skills must be interrelated/integrated in order to perform that task/sub-task--and the mission itself--successfully.

As was said, the Helmreich Performance Markers and their decomposition are included. Some examples, from Figure 1, of the "shorthand" that the model uses is as follows:

D 1 means Cluster D, Category 1

and

C 810 means Cluster C, Category 8, Marker 10

The mission sub-tasks are also further broken out/decomposed into smaller elements. For example:

"6.1.1.2" means (left-to-right)

Task 6.1, with sub-task .1 and element .2

Task 6.1 is to perform an initial approach. Sub-task .1 (i.e., 6.1.1) of it is to assess environmental factors, and 6.1.1.2 represents element .2 of subtask .1 of task 6.1.

The tasks, subtasks, and elements came from an existing United Airlines task analysis which is not included due to its size.

The criticality and strength of the interrelationships between the CRM performance markers and the flight control/technical skills may be able to be measured and evaluated (see Figure 2). During Phase II, we will try to develop and refine techniques and scales for any interactions.

1-4 Awareness of risk factors strongly 2-4 supports situation assessment and decision behavior and vice versa.

1-2 Communications process strongly supports situation awareness (shared mental model).

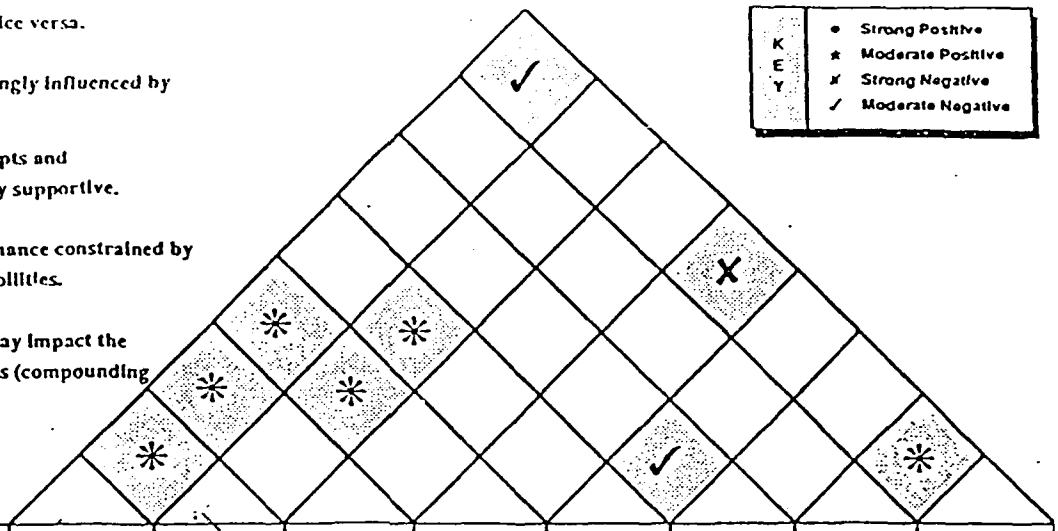
1-3 Free exchange of objective information strongly support team building.

1-5 Situation awarenes strongly influenced by flight path prediction.

7-8 System operating concepts and reconfiguration strongly supportive.

5-6 Vertical profile performance constrained by drag/deceleration capabilities.

1-8 System malfunctions may impact the decision making process (compounding factor).



CR	6.1. Perform Initial Approach	Communications Process & Decision Behavior	Workload Management & Situation Awareness	Team Building & Maintenance	Operational Integrity	Flight Maneuvers & Attitude Control	Propulsion/ Lift/Drag Control	Systems Operation	Malfunction Warning & Reconfiguration
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	6.1.3. Reconfigure/ Check Systems		C71					613 G1 G3	6131 I11
	6.1.4. Reconfigure/ Check Aircraft		C71		6143 614371 D4		6141 F1 F2		
67.1	6.1.5. Fly Lateral Track		615 6155 C77 C88 C810	BS4	6152 6157 D2	61521 6153 6154 E1 E2 E3 E5			
74.0	6.1.6. Fly Vertical Profile		616 C77 C88 C810	BS4	6161 D2	6162 E1 E2 E4 F5 F6	6163 61632 F2		
	6.1.7. Perform Communications	617 A25 A41							

Figure 2

III. THE PHASE II WORKSHOP ("SPECIAL TEAM")

A. Objectives

A general introduction to these, and a general statement of them, has been presented in Section II. As the workshop progresses, things will arise (or fall away) which can change any prior, stated set of objectives. The modified Delphi format that will be used should provide the framework for achieving these goals--in a relatively short time and with quality results.

On Day I of the workshop, we will present a specific, sequenced set of objectives--for discussion, clarification, modification, agreement--and, completion.

B. Format

We will form two work teams. Each team will work as individuals on some iterations and as a team on some iterations--but, always as a team for finalizing data/achieving consensus. Additionally, the entire workshop will function as a "super-team", meeting to integrate and finalize the data from the two work teams.

The workshop will be facilitated by Dr. Ron Lofaro who has designed and used a highly modified Delphi process to develop operational aviation systems on two other occasions.

There may be some brief training and discussion on group function, consensus and "group-think".

There will be a complete and comprehensive set of protocols and reference materials provided--and discussed--prior to any data being generated.

The Workshop flow-chart, as to the model:

Phase II Workshop

Time: 0930 on 19 Nov. to 1600 on 21 Nov.

Place: Washington, DC

Participant List:

Mr. Jan Demuth, FAA

Mr. Doug Farrow, FAA

Dr. Ron Lofaro, FAA

Capt. Fred Lorenz, The Boeing Company

Capt. Frank Tullo, Continental Airlines

Capt. Jon Tovani, Delta Air Lines

Capt. Ted Mallory, Northwest Airlines

Capt. Stan Smartt, Northwest Airlines

Capt. Kevin Smith, United Airlines

Capt. Bill Hamman, M.D., United Air Lines

LTC Mike Jobanek, USAFR/MiTech, Inc.

Dr. Tony Ciavarelli, USNPGS

IV. HOMEWORK ASSIGNMENT

1. Please read this package carefully.

2. Read over the performance markers, both CRM and technical. Critique these as to completeness and correctness; write down what you feel is missing or needs to be changed. Please bring your notes when you come to the Workshop (refer to them as Objective 1A).

3. Read over the performance-anchored rating scales used for the performance markers. As in 1. above, critique these and bring these notes with you also (refer to them Objective 1B).

4. Consider the Mission Performance Model. How do you feel it can be used best (e.g., in aircrew training? LOFT evaluations? check airmen?)? And, where do you feel it can have the least, or no, value? In doing this, refer to the most current draft of the CRM Advisory Circular. Again, whatever notes you make here, please bring them to the Workshop (refer to them as Objective III).

5. Please fill out the Participant Data Sheet (Appendix C) and mail to:

Dr. Ronald J. Lofaro
ATTN: ARD-200
Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, D.C. 20591

APPENDIX A OF THE PHASE I PACKAGE

CREW RESOURCE MANAGEMENT

(CRM)

ADVISORY CIRCULAR 120-51

Draft 2.4

[In the Final Report on the Workshop, this has been replaced with Appendix C, the most recent draft of the Advisory Circular.]

APPENDIX B OF THE PHASE I PACKAGE

CREW PERFORMANCE MARKERS:

HUMAN and TECHNICAL FACTORS

CREW PERFORMANCE MARKERS

Crew Performance Markers are conceptualized as a way to understand operational quality standards that are keys to an efficient, safe and successful operation.

Crew performance markers in effect provide for a "model" of effective crew performance. This "performance model", once specified, can be used to 1) construct meaningful line oriented flight training sessions and 2) evaluate crew performance in a way that provides for meaningful feedback.

However, before either training program development or crew performance assessment can occur, a conceptual understanding of crew performance markers is considered necessary. They are separated into human factors and technical related items.*

I. CREW PERFORMANCE MARKERS--HUMAN FACTORS

A. Communications Processes and Decision Behavior

Briefing (conduct and quality). The effective briefing will be operationally thorough, interesting, and will address coordination, planning, and problems. (Although primarily a Captain responsibility, other crewmembers may add significantly to planning and definition of potential problem areas.)

Inquiry/Advocacy/Assertion. This rating assesses the extent to which crewmembers advocate the course of action they feel best, even when it involves conflict and disagreements with others.

Crew self-critique (decisions and actions). This item evaluates the extent to which crewmembers, conduct and participate in a debriefing, operational review, and critique of activities, which includes the product, the process, and the people involved. Critique can, and should, occur during an activity, and/or after completion of the activity.

Conflict resolution. If crewmembers engage in conflict while attempting to decide on a course of action or for any other reason, the effectiveness of means used to resolve the conflict and the use of available resources is rated.

* Bold, italicized markers apply to Advance Technology Flightdecks.

Communications/Decisions. This rating reflects the extent to which free and open communication is practiced. It includes providing necessary information at the appropriate time (for example, initiating checklists, alerting others to developing problems). Active participation in decision-making process encouraged and practiced. Questioning of actions and decisions is proper. Decisions made are clearly communicated and acknowledged.

1. Establishes team concept and environment for open/interactive communications (e.g., calls for questions or comments, answers questions directly, listens with patience, does not interrupt or "talk over", does not rush through the briefing, makes eye contact as appropriate).

2. Identifies potential problems such as weather, delays, and abnormal system operations. Sets expectations for how deviations from S.O.P. are to be handled.

3. Provides guidelines for crew actions -- division of labor and crew workload addressed.

4. Includes cabin crew as part of team in the briefing, as appropriate.

5. Operational decisions are clearly stated to other crewmembers and acknowledged.

6. "Bottom lines" are established and communicated for safety of operations. The "big picture" and the game plan are shared within the team including flight attendants and others.

7. Crewmembers are encouraged to state their own ideas, opinions, and recommendations.

8. Crewmembers speak up, and state their information with <u>appropriate</u> persistence, until there is some clear resolution and decision.

9. Crewmembers are encouraged to ask questions regarding crew actions and decisions, and answers are provided openly and non-defensively.

10. Critique is given at appropriate times, both low and high workload, and is made a positive learning experience for the whole crew--feedback is specific, objective, based on observable behavior, and given constructively.

11. Critique is accepted objectively and non-defensively, deals with positive as well as negative aspects of crew performance.

12. When conflicts arise, the crew remains focused on the problem or situation at hand. Crewmembers listen actively to ideas and opinions and admit mistakes when wrong.

13. Assignment of blame is avoided -- the focus is on determining what is right, not who is right. Crewmembers treated with empathy and respect. When there is time, crewmembers explain "why" particular decisions were made.

14. ***Establishes policy guidelines for the operation of automated systems (i.e. when system will be disabled, programming actions that must be verbalized and acknowledged).***

15. ***Specifies PF and PNF duties and responsibilities with regard to automated systems.***

16. ***Crewmembers verbalize and acknowledge entries and changes to automated systems.***

17. ***Crewmembers question status and programming of automated systems to verify and ensure situational awareness.***

B. Team Building and Maintenance

Leadership, Followership, and Concern for Tasks. This rating evaluates the extent to which appropriate leadership and followership is practiced. It reflects the extent to which the crew is concerned with the effective accomplishment of necessary tasks.

Interpersonal Relationships/Group Climate. This evaluation reflects the quality of observed interpersonal relationships among, and the overall ***climate*** of, the flightdeck. This is independent of demonstrated concern with accomplishment of required tasks.

1. Coordinates flightdeck activities to establish proper balance between authority and assertiveness; acts decisively when the situation requires.

2. Demonstrates desire to achieve most effective possible operation

3. Ensures that group climate is appropriate to operational situation (i.e. social conversation in low workload conditions but not high).

4. Shows sensitivity and ability to adapt to other crewmembers' personalities and personal characteristics.

5. Recognizes symptoms of psychological stress and fatigue in self and others (e.g., note when a crewmember is not communicating, and draw him/her back into the team; recognize when they are experiencing "tunnel vision," and seek help from the team).

6. "Tone" in the cockpit is friendly, relaxed, supportive.

7. Ensures that non-operational factors such as social interaction do not interfere with necessary task duties.

8. During times of low communication, crewmembers check in with each other to see how they are doing.

9. ***Recognizes and deals with demands and resources posed by operation of automated systems.***

10. ***Reverts to lower level of automation when programming demands could reduce situational awareness or create work overloads.***

C. Workload Management and Situational Awareness

Preparation/Planning/Vigilance. This rating indicates the extent to which crews anticipate contingencies and actions that may be required. Excellent crews are always "ahead of the curve" while poor crews continually play catch up. Vigilant crews devote appropriate attention to required tasks and respond immediately to new information. ***A crew indulging in casual social conversation during periods of low workload is not necessarily lacking in vigilance if flight duties are being discharged properly.***

Workload Distribution/Distraction Avoidance. This is a rating of time and workload management. It reflects how well the crew managed to distribute the tasks and avoid overloading individuals. It also considers the ability of the crew to avoid being distracted from essential activities and how work is prioritized.

1. Actively monitors weather, aircraft systems, instruments and ATC communications, sharing relevant information with the rest of the crew.

2. Avoids "tunnel vision," being aware of factors such as stress that can reduce vigilance--thus, monitoring the performance of other crew members.

3. Stays "ahead of curve" in preparing for expected or contingency situations (including approaches, weather, etc.)

4. Verbally insures that cockpit and cabin crew are aware of plans.

5. Workload distribution is clearly communicated and acknowledged to maximize efficiency.

6. Ensures that secondary operational tasks (i.e. dealing with passenger needs, company communications) are prioritized so as to allow sufficient resources for dealing effectively with primary flight duties.

7. Recognizes and reports overloads in self and others.

8. ***Plans for sufficient time prior to maneuvers for programming of automated systems.***

9. ***Ensure that all crewmembers are aware of status and changes in automated systems parameters.***

10. ***Crewmembers recognize potential distractions posed by automation and take appropriate preventive action, including reversion to lower levels of automation.***

D. Operational Integrity

Mission Completion and Risk Management. This rating assesses the ability to complete the mission while minimizing risk and avoiding catastrophe.

1. When confronted with an unusual event, evaluate options thoroughly without becoming committed to a single course of action with a high degree of risk.

2. Preformulate strategies to deal effectively with critical operational situations.

3. Consider desired vs. expected outcome. Project state or condition of aircraft to expected terminal condition and map this to desired condition.

Regulatory Compliance. This rating evaluated the adherence to all pertinent operational regulations including FAR's, operational specifications, etc.

1. Conscientious use of SOP'S.

2. Intentional non-compliance when this is judged to be the safest course of action.

Schedule Reliability. Significant delays will impose schedule and economic penalties and must be considered during the conduct of the operation.

1. Mission plan factors in destination arrival time.

2. Enroute decisions factor in destination arrival time.

3. Anticipated operational delays are communicated promptly.

Operational Economy. This rating involves considerations of efficient, economic flight operations performance. Fuel conservation is a significant component of economy.

1. Enroute burn-out considered as part of all major planning decisions.

2. Approach speeds, flap settings and runway length are considered to minimize brake wear.

II. Crew Performance Markers--Technical Factors

This area focuses on the crew as a unit and how well they discharge the technical aspects of the mission. It specifically addresses precision maneuvers; propulsion, lift and drag control; systems operations and malfunction warning and reconfiguration.

A. Flight Maneuvers and Attitude Control.

Flight maneuvers involve precision manipulation of the velocity vector of the aircraft in time and space. Attitude control involves the maintenance of appropriate longitudinal and lateral transition and terminal positioning. Major focus here is on the "performance and control" aspects of flying.

1. Instrument Interpretation: properly interpret control, performance and AFDS indications.

2. Instrument Selection: select optimum displays and functions for specific mission tasks.

3. Lateral Navigation: predict and execute optimum course intercept, capture and track optimum course to achieve specific mission objective.

4. Vertical Navigation: monitor or control descent rate and/or path to achieve target vertical points. Maneuver aircraft to maintain optimum descent path and recognize status of the velocity vector.

5. Attitude Control: maintain optimum pitch attitude and bank angle control for appropriate flight conditions.

6. Velocity Vector Control: maintain optimum velocity vector control to achieve target vertical points.

7. Trim Control: maintain "in trim" condition to achieve a stable platform.

8. Assess Aircraft State: maintain position/terrain/obstacle awareness.

9. Approach Stabilization: achieve and maintain a stabilized final approach state. Considerations here include:
   a) Configuration management
   b) Speed management
   c) Glideslope control
   d) Power management
   e) Localizer heading control
   f) In close line up, attitude and wings control.

B. Propulsion/Lift/Drag Control

Propulsion, lift and drag control involves achieving the optimum aircraft energy state to in turn achieve a specific mission objective.

1. Instrument Interpretation: proper and timely entre of key propulsion, lift and/or drag indications.

2. Energy Management: achieve and maintain target airspeed consistent with target altitudes and mission constraints. Optimum employment of aircrafts' acceleration/ deceleration rates.

3. Power Control: smooth, precise application of power to achieve desired mission objectives.

4. Lift Control: optimize lift control systems to achieve desired mission objectives within known mission constraints.

5. Drag Control: manage aircraft platform and aerodynamic drag to achieve desired deceleration rates.

C. System Operations

Systems operations involve the location and interpretation of controls and displays; the knowledge of operating concepts/limits; and the demonstrated use of operating procedures to accomplish specific mission objectives.

1. Instrument Interpretation: location of pertinent instruments and the interpretation of mission critical information.

2. Operating Concepts: system operating concepts and functions that permit timely utilization of all system resources.

3. Operating Limits: limitations of system capabilities that may impact mission performance.

4. Operating Procedures: normal operating procedures that permit timely and effective utilization of all key system functions.

D. Malfunction Warning and Reconfiguration

Malfunction warning involves assessing the information provided that indicates a degradation of system capability and/or integrity. System reconfiguration involves the means by which a system-aircraft is configured for continued safe flight after an abnormality has occurred.

1. Instrument Interpretation: assessment of mission-critical information indication that a system/aircraft degradation has occurred.

2. Operating Concepts: system operating concepts that permit timely warnings of actual or impending system failures.

3. Operating Procedures: system/aircraft reconfiguration procedures to ensure continued safe flight is possible.

E. Energy Management

Effective Energy Management requires the use of altitude, airspeed, fuel and angular position to arrive at a predetermined flight fix (or portion in space) at a specified time while maintaining precise flight trajectory and attitude control.

Establishing an optimum flight trajectory profile while maintaining target state parameters is the ultimate aim of energy management and requires significant skill to perform this in a modern low drag, high performance aircraft.

Extensive studies have been conducted relating to energy management for military tactical aircraft (see Bridenbach, Ciavarelli, 1985). Most observers have seen little application for this research in the civil transport environment. However, recent interest in optimal recovery techniques for windshear encounters (Meile, et. al., 1990) suggest that more training emphasis may be needed in energy/trajectory management, not only for unusual windshear encounters but also for the complete approach and landing phase of the transport mission.

Energy. For the purpose of this report "energy" can be defined as consisting of the following:
1. Airspeed
2. Altitude
3. Angular position (relative to some point)
4. Fuel
5. Thrust available
6. Drag

Management. For the approach and landing phase of the transport mission, "management" of energy consists of:
1. Control of thrust
2. Control of drag
3. Optimization of flight trajectory
4. Optimization of angular position
5. Optimization of fuel

6. Optimization of descent rate
7. Optimization of speed decay rate

From the above it can be seen that "Energy Management" is a conceptually complex aircrew activity that clearly needs a high degree of skill for successful execution.

III. SUMMARY

The Mission Performance Model, complete with each crew performance marker is shown in Figure 1. Here, human factors as well as technical performance clusters are specified along with the applicable markers under each cluster. For example, under workload management and situational awareness, key markers include: preparation, planning, vigilance, workload distribution, and distraction avoidance.

Similarly, under the cluster entitled "Propulsion/Lift/Drag Control"; key markers include: instrument interpretation, energy management, power control, lift control and drag control. When all these markers are combined into their various categories, the concept of a mission performance model emerges.

CREW PERFORMANCE MARKERS

Revision A (4/18/91)

CLUSTER	CATEGORY	MARKER	ASSESSMENT
A: Communications Process and Decision Behavior	1: Briefing *The effective briefing will be operationally thorough, interesting, and will address coordination, planning, and problems. [Although primarily a Captain responsibility, other crewmembers may add significantly to planning and definition of potential problem areas.]*	1) Identifies potential problems such as weather, delays and abnormal system operations. Sets expectations for how deviations from S.O.P. are to be handled.	1 2 3 4 5
		2) Provides guidelines for crew actions - division of labor and crew workload addressed.	1 2 3 4 5
		3) Includes cabin crew as part of team in the briefing, as appropriate.	1 2 3 4 5
		4) Establishes policy guidelines for the operation of automated systems (i.e., when system will be disabled, programming actions that must be verbalized and acknowledged).	1 2 3 4 5
		5) Specifies PF and PNF duties and responsibilities with regard to automation.	1 2 3 4 5
		6) Plan factors in potential problems.	1 2 3 4 5
		7) Plan addresses considerations of risk.	1 2 3 4 5

1	2	3	4	5
Poor Performance Significantly Below Expectations	Minimally Acceptable Performance Improvement Needed	Satisfactory or Standard Performance	Very Good, Above Average Performance	Exceptional Performance Significantly Above Standard

CREW PERFORMANCE MARKERS

Revision A (4/18/91)

CLUSTER	CATEGORY	MARKER	ASSESSMENT
C: Workload Management and Situational Awareness	8: Workload Distribution/ Distractions Avoidance *This is a rating of time and workload management. It reflects how well the crew managed to distribute the tasks and avoid overloading individuals. It also considers the ability of the crew to avoid being distracted from essential activities and how work is prioritized.*	1) Workload and time are managed to maximize efficiency.	1 2 3 4 5
		2) Workload is managed to maximize crew efficiency.	1 2 3 4 5
		3) Time is managed to optimize crew performance.	1 2 3 4 5
		4) Workload distribution is clearly communicated and acknowledged to maximize efficiency.	1 2 3 4 5
		5) Stays "ahead of curve" in preparing for expected or contingency situations (including approaches, weather, etc.	1 2 3 4 5
		6) Ensures that secondary operational tasks (i.e., dealing with passenger needs, company communications) are prioritized so as to allow sufficient resources for dealing effectively with primary flight duties.	1 2 3 4 5
		7) Recognizes and reports overloads in self and others.	1 2 3 4 5

1	2	3	4	5
Poor Performance Significantly Below Expectations	Minimally Acceptable Performance Improvement Needed	Satisfactory or Standard Performance	Very Good, Above Average Performance	Exceptional Performance Significantly Above Standard

CREW PERFORMANCE MARKERS "TECHNICAL"

Revision A (4/18/91)

CLUSTER	CATEGORY	MARKER	ASSESSMENT
E: Flight Maneuvers and Attitude Control	*Flight maneuvers involves precision manipulation of the velocity vector of the aircraft in time and space. Attitude control involves the maintenance of appropriate longitudinal and lateral transition and terminal positioning. Major focus here is on the "performance and control" aspects of flying.*	7) Trim Control: Maintain "in trim" condition to achieve a stable platform.	1 2 3 4 5
		8) Assess Aircraft State: Maintain position/terrain/obstacle awareness.	1 2 3 4 5
		9) Approach Stabilization: Achieve and maintain a stabilized final approach state. Considerations here include: a) Configuration management b) Speed management c) Glideslope control d) Power management e) Localizer/heading control f) In close line up, attitude and wings control.	1 2 3 4 5

1	2	3	4	5
Poor Performance Significantly Below Expectations	Minimally Acceptable Performance Improvement Needed	Satisfactory or Standard Performance	Very Good, Above Average Performance	Exceptional Performance Significantly Above Standard

APPENDIX B:

Edited Version of Phase II Materials

AIR TRANSPORT ASSOCIATION (ATA) OF AMERICA/

FEDERAL AVIATION ADMINISTRATION (FAA)

WORKING GROUP EFFORT

ON INTEGRATED

CREW RESOURCE MANAGEMENT (CRM)

PHASE II

CRM INTEGRATION

SPECIAL TEAM WORKSHOP

Washington, D. C.
19 - 21 November 1991

Phase II

Table of Contents

I. SCHEDULE

Day I

- Introductions, Logistics, Administrative.
- Presentations on CRM and the Mission Performance Model:
  - > Capt. Kevin Smith and Capt. Bill Hamman, United Air Lines
  - > Mr. Jan Demuth, FAA
- BREAK
- Distribution of Workshop materials/protocols; Discussion of Phase I materials and Phase II (Workshop) objectives and procedures.
- Group Assignments
- LUNCH
- Group Processes
- Begin Objectives

Day II and III

- Working the Objectives - at some point, finalize; IOU's; discuss next step(s).

II. WORKING OBJECTIVES

A. **Objective I:**

1. To examine the performance markers--both CRM and Technical.

2. To examine the two behaviorally anchored rating scale(s) for the above-- *both of these can be (initially and individually) a "homework" part of Phase I; the finalization via group work will do at the workshop.*

B. **Objective II:** To complete the mission performance model by:

1. Developing a criticality scale/rating methodology (or, other method) for the identification and criticality-rating of the sub-tasks/elements on any mission task.

ALTERNATE: To compare/contrast/modify/integrate (--whatever) the MPM and Figure 2 in the latest draft of the CRM Advisory. (Remainder of objective is somewhat the same.)

2. Exercise the model--use 3 tasks per phase of flight (normal; abnormal/ emergency; "other") as an initial review/critique and modification; as a check on the completeness of the task decomposition via criticality-rating (or, whatever other method was used).

3. Re-exercise the model to check any mods that were made (--same format as in II.B, IV..5 as to the number of tasks, etc.).

4. Identify/articulate any rules and algorithms embedded in the model.

5. Develop scales/rules for evaluating the existence/strength of CRM and technical skill interrelationships -- task/sub-task level.

C. **Objective III:** To identify/examine the potential uses of the model--with attention to:

1. Aircrew CRM Training development;

2. LOFT scenario development and/or evaluation;

3. Instructor Pilot/Evaluator training;

4. CRM/LOFT evaluation.

--The latest draft of the CRM AC will be used here and in Objective II as key references/input.

III. GROUP PROCESS

A. Group Functioning **[omitted from final report]**

B. Group Decision-making

There are a number of approaches which groups can use to reach decisions at various points in their problem solving activities. These are pros and cons to all these approaches. However, the approach which has the most potential for participation and interaction is consensus.

Consensus - occurs when a final solution is reached which is acceptable to everyone (Filley, 1975). Consensus must be achieved through discussion in such a way that:

1. no group member(s) is (are) placed in a win-lose position;
2. the group members do not waste time in only defending/supporting their respective positions--to the exclusion of real discussion; and,
3. group cohesion is not disrupted.

Consensus may lead to "regression toward the mean;" that is, in order to maintain group cohesion, individuals may distort their independent judgements to accommodate each other. This is to be watched for and avoided. Finally, while consensus can be a very powerful approach to decision making, it may fall far short of its potential if the group "chemistry" is improper and/or the group facilitator/leader does not have the necessary skills.

C. Some Guidelines for Effective Consensus

(The guidelines are research-based and can be used as general directions in practically any group problem-solving activity. Groups that actively attempt to follow these guidelines will get quality results.)

1. Always strive for the best answer, given the data you have to work with. Excellence is always desirable and should be actively pursued.

2. Assume that the task can be done and that some solutions may be better than others. Do not attach your self-worth to the selection of a particular item. Do not assume that someone must win and someone must lose when discussion reaches a stalemate. Try not to compete. Even if you win, the group may lose.

3. Present your position, but listen to other group members' reactions and consider them carefully before you press a particular point. State your own beliefs or opinions concerning the issues, but make certain that all group members are heard from and contribute to the discussion.

4. *Attempt to involve everyone in the discussion and decision making process. Disagreements can enhance the quality of the decision because a wide range of information and opinion maximizes the chance that a group will make a more adequate choice. Treat differences of opinion as a means of gathering more information, clarifying issues, and causing the group to seek better alternatives.*

D. Groupthink Versus Consensus

The basic differences are simple in theory, but difficult to overcome in practice. From the outside of a group, watching it as it were, consensus and groupthink can seem to be much alike, and groupthink can be so seductive and feel so good that it is easy to fall into and, even easier, to believe that it is consensus.

Consensus involves work; often it doesn't feel "good" as you work towards it, but it holds together later and the group is more cohesive and better functioning as a result.

Groupthink, which is the single biggest barrier to real consensus, seems to feel good as it happens. It builds nothing, however, except the illusion of harmony and the feelings (in some/all members) that something isn't quite right. But the rest of the group seems happy and the task seems to flow. Members self-censor to keep up this illusory harmony. There is no real critical thought and the "harmony" can disappear in a flash.

E. Groupthink Symptoms

Groupthink encompasses a number of symptoms; groupthink exists in a group to the degree that these eight symptoms are present.

1. Illusion of unanimity regarding the viewpoint held by the majority in the group and an emphasis on team play.

2. A view of the "opposition" as generally inept, incompetent, and incapable of countering effectively any action by the group, no matter how risky the decision or how high the odds are against the plan of action succeeding.

3. Self-censorship of group members in which overt disagreements are avoided; facts that might reduce support for the emerging majority view are suppressed; faulty assumptions are not questioned, and personal doubts are suppressed in the form of group harmony.

4. Collective rationalization to comfort one another in order to discount warnings that what the group seems to have agreed upon is either unworkable or highly unlikely to succeed.

5. Self-appointed mindguards within the group that function to prevent anyone from undermining its apparent unanimity and to protect its members from unwelcome ideas and adverse information that may threaten consensus.

6. Reinforcement of any seeming consensus by direct pressure on any dissenting group member who expresses strong reservations or challenges, or argues against the apparent unanimity of the group.

7. A shared feeling of unassailability marked by a high degree of esprit de corps, by implicit faith in the wisdom of the group, and by an inordinate optimism that disposes members to take excessive risks.

IV. PROTOCOLS

Phase II CRM Integration Workshop

NOTE: A 7-page set of protocols was provided to the Workshop participants. Due to space limitations and to the various, on-the-spot changes made during the Workshop itself, these are not reproduced here. If you are interested in them, please call Dr. Ron Lofaro, FAA, at (212) 267-8529.

APPENDIX C:

Latest Draft

FAA CRM Advisory Circular 120-51

CREW RESOURCE MANAGEMENT TRAINING

ADVISORY CIRCULAR

DRAFT 3.4 February 27, 1992

CONTENTS

Crew Resource Management Training AC No: 120-51a

Draft 3.4 Rev. 2/27/92
ATA AQP Committee: Advisory Circular Focus Group 1/7/92
Air Carrier Training Working Group 2/26/92

1. PURPOSE. This advisory circular (AC) presents guidelines for developing, implementing, reinforcing and assessing training programs in the human factors of flight operations for flight crewmembers and other personnel. These programs are known as Crew Resource Management and are designed to become an integral part of training and operations.

2. RELATED FAR SECTIONS and ADVISORY CIRCULARS.

a. Part 121, Subpart N (Training). 121.400-405, 121.409-422, 121.424, 121.427.

b. Part 121, Subpart O (Crewmember Qualifications). 121.432-433, 121.434, 121.440-443.

c. Part 135, Subpart E (Flight Crewmember Requirements. 135.243-245.

d. Part 135, Subpart G (Crewmember Testing Requirements). 135.293-295, 135.299-301.

e. Part 135, Subpart H (Training). 135.321-331, 135.335-351.

f. Advisory Circular 120-35B Line Oriented Simulations

g. SFAR 58. Advanced Qualification Program
Advanced Qualification Program Advisory Circular

3. RELATED READING MATERIAL. For detailed information on the recommendations made in this AC, the reader is encouraged to review *Crew Resource Management: An Introductory Handbook* published by the FAA (tentative title and publication). Additional background material can be found in *Cockpit Resource Management Training: Proceedings of a NASA/MAC, Workshop, 1987.* The National Aeronautics and Space Administration (NASA) Conference Proceedings (CP) number is 2455. The National Plan for Aviation Human Factors defines research issues related to crew coordination and training. Copies may be purchased from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22161, (703) 487-4650. Descriptions of current research and organizational experience can be found in Helmreich & Wilhelm (1992) "Outcomes of CRM training", *International Journal of Aviation Psychology* and in E.L. Wiener, B.G. Kanki, & R.L. Helmreich (Eds.). (In press). *Cockpit Resource Management.* Orlando: Academic Press.

4. DEFINITIONS.

a. Human Factors. Human factors is a multidisciplinary field that draws on the methods and principles of the behavioral and social sciences, engineering, and

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physiology to optimize human performance and reduce human error. In short, human factors has become an applied science of people working together with machines. Just as individual errors can degrade the performance and safety of a system because of the way the hardware is designed or because of inadequate operator training, so too can errors in the design and management of *crew tasks* and of *organizations* degrade system performance.

b. Crew Resource Management. The application of human factors concepts in the flightdeck environment was initially known as Cockpit Resource Management. More recently, as human factors programs have come to include other participants in the aviation system such as cabin crews and maintenance personnel, the phrase Crew Resource Management (CRM) has come into wide use. CRM refers to the effective use of all available resources, human, hardware, and informational. A more modern definition includes not only the cockpit crew but also all other groups that routinely work with that crew and are involved in decisions required to operate a flight safely. These groups include but are not limited to:

(1) dispatchers
(2) cabin crewmembers
(3) maintenance personnel
(4) air traffic controllers

CRM encompasses optimizing both the person-machine interface and interpersonal activities including effective team formation and maintenance, information transfer, problem solving, decision making, maintaining situation awareness, and dealing with automated systems. Training in CRM thus involves initial indoctrination and recurrent training and reinforcement of crews in human factors concepts in the aviation system.

5. BACKGROUND.

a. Investigations into the causes of air carrier accidents have shown that human error is a contributing factor in between 60 and 80 percent of all air carrier incidents and accidents. This AC provides guidelines for FAR Parts 121 and 135 certificate holders to establish human factors programs designed to increase the efficiency with which flight crewmembers interact in the cockpit by focusing on communication skills, teamwork, task allocation, and decision making.

b. A long-term NASA research program has demonstrated that these types of incidents have many common characteristics. One of the most compelling observations of this program and other research studies is that many problems encountered by flightcrews have very little to do with the more technical aspects of operating a multi-person crew aircraft. Instead, they are associated with poor group decision making, ineffective communication, inadequate leadership, and poor management. Training programs historically emphasized almost exclusively the technical aspects of flying and do not deal effectively with various types of crew management strategies and techniques that are also essential to safe flight operations.

c. These observations have recently led to a developing consensus in both industry and government that more training emphasis needs to be placed upon the factors that influence crew coordination and the management of crew resources. CRM training programs have been or are being developed by most major and some regional air carriers.

d. A 1986 NASA workshop on CRM training attended by representatives of many segments of the aviation community, has produced a series of recommendations for training programs in this area. These guidelines, while not mandatory, provide useful background information for understanding the critical elements of human factors training.

e. Continuing research sponsored by NASA and the FAA evaluating the impact of CRM training indicates that initial indoctrination causes significant improvement in attitudes regarding crew coordination and flightdeck management. In programs that also provide recurrent training and opportunities to practice CRM concepts, significant changes in observed behavior on the flightdeck and crew performance during Line Oriented Flight Training have been found. Crews with CRM training operate more effectively as teams and cope more effectively with non-standard situations.

f. This research also shows that when there is not effective, recurrent training in and reinforcement of CRM concepts, improvements in attitudes found after initial indoctrination tend to disappear and revert to former levels.

6. BASIC CONCEPTS OF CREW RESOURCE MANAGEMENT.

While there are many approaches and techniques useful in CRM training, it seems clear that certain features are necessary. The training should focus on the functioning of crews as *intact teams,* not simply as a collection of technically competent individuals. The training should provide opportunities for crewmembers to practice the skills that are necessary to be good team leaders and team members. This requires that training exercises include all crewmembers functioning in the same roles they normally perform in flight. CRM training should help crewmembers learn how to behave in ways that foster *crew* effectiveness. It should also help crewmembers learn that how they behave during normal, routine circumstances can have a powerful impact on how well they function during high workload, stressful situations. During emergency situations, it is highly unlikely (and probably undesirable) that any crewmember will take the time to reflect upon his or her CRM training to figure out how to act. However, actions normally practiced during more relaxed times increase the chances that a crew will handle stressful situations more competently.

Findings from research show that lasting behavior change in any environment cannot be achieved in a short period, even if the training is very well designed. Trainees need time, awareness, practice and feedback, and continuing reinforcement to learn lessons that will endure over long periods of time. In order to be effective, CRM concepts must be integrated into all aspects of training and operations.

CRM, is defined by the following basic characteristics:

(a) It is a comprehensive system of applying human factors concepts to improve crew performance

(b) It is designed for all operational personnel.

(c) It can be extended to all forms of aircrew training.

(d) It concentrates on crewmember attitudes and behaviors and their impact on safety.

(e) It uses the crew as the unit of training.

(f) It is training that requires the active participation of all crewmembers. It provides an opportunity for individuals and crews to examine their own behavior and make decisions on how to improve cockpit teamwork.

(g) It uses check airmen and instructors who are highly qualified and specially trained in CRM.

(i) Line Oriented Flight Training (LOFT) sessions provide an extremely effective means of practicing CRM skills and receiving feedback and reinforcement.

(ii) Video feedback during debriefing of LOFT and other training should optimally be provided so that crewmembers could asses their skills as individuals and team members.

(iii) In cases where simulators are not available, crewmembers can participate in group problem-solving exercises designed to exercise CRM skills. Through video feedback during debriefing, they can then assess the positive and negative actions of all crewmembers.

(iv) Crewmembers may also participate in role-playing exercises designed to provide practice in developing strategies for dealing with incidents and to allow analyses of behaviors during incidents. Again, video feedback is useful for assessment and feedback during debriefing of crew abilities in such areas as decision making, team participation, and leadership.

(iv) Attitude and/or personality measures can also be used to provide feedback to participants, thereby allowing them to assess their individual strengths and weaknesses.

7. FUNDAMENTALS OF CRM IMPLEMENTATION

Both research and the operational experience of airlines implementing CRM programs have suggested that greatest impact is achieved if a number of steps are taken. The following are actions that have been observed to increase program effectiveness. A number of these issues are discussed in more detail in later sections.

a. Demonstrate total commitment to the program. Programs are received much more positively when senior management, flight operations, and flight standards personnel publicly support the concepts and provide necessary resources. In addition Flight Operations and Training Manuals should embrace CRM concepts and provide crews with necessary procedures, policy guidance, and training.

b. Communicate the nature and scope of the program prior to startup. Providing crews with an expectation of what the training will involve and plans for initial and continuing training can prevent misunderstandings regarding the focus of the training and its implementation.

c. Assess the status of organizations before implementation. It is important to know how widely CRM concepts are understood and practiced before designing specific training. Surveys of flightcrews, observation of crews in line observations, and analysis of operational incident reports can all provide essential data for program designers.

d. Customize the training to reflect the nature and needs of the organization. Using knowledge of the state of the organization, priorities should be established for topics to be covered including special issues such as the effects of mergers or the introduction of advanced technology aircraft. This approach can increase the relevance of training for crewmembers.

e. Define the scope of the program. Institute special CRM training for key personnel including check airmen and instructors. It is useful to provide training for these groups prior to beginning training for line crews. CRM training may be expanded to include dispatchers, cabin crews, maintenance personnel and other team members as appropriate. It is also helpful to develop a long term strategy for program implementation.

f. Institute quality control procedures. It has proved helpful to monitor the delivery of training and to determine areas where training can be strengthened. This can be accomplished by providing special training for program instructors (usually called facilitators) and using surveys to collect systematic feedback from participants in the training.

8. COMPONENTS OF CRM TRAINING.

Overall objectives of CRM. CRM training is designed to prevent incidents and accidents and to improve crew coordination and performance. The following components have been identified as critical for effective CRM implementation. They do not represent a fixed sequence of presentation. In practice, many airlines combine elements of each in both initial and recurrent training and in checking.

a. Initial Indoctrination/Awareness.

(1) Indoctrination/awareness typically consists of classroom presentations and focuses on communications and decision making, interpersonal relations and crew coordination, and leadership. In this component of CRM programs the concepts are developed, defined, and related to line operations and the safety of operations. This part of the training also provides a common terminology and conceptual framework for identifying and describing crew coordination problems.

(2) This can be accomplished by a combination of training methods such as lecture presentations, discussion groups, role-playing exercises, computer-based instruction, and videotape examples of good and poor team behavior..

(3) Initiating indoctrination/awareness training includes the development of a curriculum that addresses CRM skills that have been demonstrated to influence crew performance. To be most effective, the curriculum should both define the concepts involved and relate directly to operational issues crews face. Many organizations have found it useful to survey crewmembers to determine attitudes regarding crew coordination and cockpit management and to examine operational problems to prioritize training issues to address topics of greatest operational significance.

(4) Effective indoctrination/awareness training increases the credibility of the concepts and helps in changing attitudes to be more favorable to human factors concerns. It may also demonstrate more effective communications practices and enhance interpersonal skills. However, it is important to realize that this is only a necessary first step. Many programs rely almost exclusively on this aspect of training,

but classroom instruction alone will not fundamentally alter crewmember attitudes and behavior over the long term.

b. Recurrent-Practice and Feedback.

(1) CRM training should be instituted as a regular part of the recurrent training requirement. Recurrent CRM training should include refresher curriculum and practice and feedback exercises such as LOFT with video feedback, or a suitable substitute such as a flight training device employing video feedback. It is particularly important that some of these recurrent CRM exercises take place with a full crew--each member operating in their normal crew position. For example, recurrent training LOFT exercises designed for CRM should be conducted with actual crews as much as possible.

(2) Recurrent practice and feedback training allows participants to employ newly acquired skills in communications and interpersonal relationships and to receive feedback on their effectiveness. Feedback has great impact when it comes from self-critique and peers with the guidance of a facilitator with special training in assessment and debriefing techniques. Effective feedback will reflect the operational factors defined in the Indoctrination/awareness Phase and will relate to specific behaviors. Practice and feedback are best accomplished through the use of simulators or training devices and video recording. Video feedback, under the guidance of a facilitator is particularly effective because it allows participants to view themselves from a third-person perspective; this promotes acceptance of one's weak areas, which encourages attitude and behavioral change.

c. Continuing Reinforcement

(1) No matter how effective the classroom curriculum, interpersonal drills, LOFT exercises, and feedback techniques are, a single exposure will be insufficient. The attitudes and norms that contribute to ineffective crew coordination have developed over a crewmember's lifetime. It is unrealistic to expect a short training program to reverse years of habits. To be maximally effective, CRM should be embedded in training and human factors concepts should be stressed in line operations and evaluation.

(2) CRM should become an *inseparable part* of the organization's culture.

(3) There is a natural tendency to think of CRM as training only for the "managers" or captains. However, this notion misses the essence of the primary CRM training objective--the prevention of *crew-related* incidents and accidents. It should be most effective in the entire crew context, and this requires training exercises that include all crewmembers working together and learning together. In the past, much of flightcrew training has been separated by crew position, and while this may be effective for certain types of training (e.g., technical skills and systems knowledge, specialized issues in upgrade training, etc.), it should not be exclusively employed in CRM training.

(4) Reinforcement can be accomplished in many different areas. Training such as joint cabin and cockpit crew training in security can deal with many human factors areas. Dispatch, maintenance, and gate agent training can also include and reinforce CRM concepts.

9. SUGGESTED CURRICULUM TOPICS.

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The following topics have been included in many current CRM programs and have proved useful. However, the specific content of training and organization of topics should reflect organizational cultures and needs. Appendix 1 provides an example set of behavioral markers for each topic. These markers may be helpful in curriculum development and in LOFT design.

(i) Communications Processes and Decision Behavior. This area includes internal and external influences on interpersonal communications. External factors include barriers such as rank age, and gender and organizational cultures. Internal factors include listening and decision making skills, conflict resolution techniques, and the use of appropriate assertiveness and advocacy. Specific topics could include the following:

(a) Briefings (conduct and quality). Training in addressing both operational and interpersonal issues and establishing open communications.

(b) Inquiry/Advocacy/Assertion. Showing the benefits when crewmembers advocate the course of action they feel best even though it may involve conflict and disagreement with others.

(c) Crew self-critique (decisions and actions). Learning the uses of operational review, feedback, and critique of actions including the process and the people involved. To assure that decisions and actions taken are appropriate, it is essential that crews review them during the course of flights with inputs from all participants. In addition, one of the best techniques to reinforce effective human factors practices is through a careful debriefing of activities highlighting the processes that were followed. To make self-critique effective, it is essential that each crew member be able to recognize and assess effective and ineffective team behavior and information exchange.

(d) Conflict resolution. Defining and showing means to resolve disagreements among crew members over appropriate courses of actions or conflicting information. Demonstrating techniques for maintaining open communication in the face of conflict.

(e) Communications and Decision Making. Demonstrating effective techniques of seeking and evaluating information. Showing the influence of cognitive factors and biases on decision quality. Research into decision processes in operational settings and under stressful conditions is still at a relatively basic level. Nevertheless, there are benefits in providing crews with operational models of group decision process that they can utilize in situations where complex information must be processed to make optimal choices.

(ii) Team Building and Maintenance. This area includes interpersonal relationships and practices. Effective leadership and followership along with interpersonal relationships are key concepts to be stressed. Curricula can also include recognizing and dealing with different personalities and personal operating styles. Operational factors include:

(a) Leadership/Followership/Concern for task. Showing the benefits of the practice of effective leadership through coordinating activities and maintaining proper balance between authority and assertiveness. Keeping the goals of safe and efficient operations central.

(b) Interpersonal relationships/Group climate. Demonstrating the usefulness of showing sensitivity and to other crewmembers' personalities and styles. The importance of recognizing symptoms of fatigue and stress and taking appropriate action. Emphasizing the value of maintaining a friendly, relaxed, and supportive tone in cockpit.

(iii) Workload Management and Situation Awareness. This topic area stresses the importance of maintaining awareness of the operational environment and anticipating contingencies and actions that may be required. Instruction may address practices (i.e., vigilance, effective planning and time management, task prioritizing, avoidance of distractions) that result in higher levels of situation awareness. The following operational factors can be included:

(a) Preparation/Planning/Vigilance. Issues include devoting appropriate attention to required tasks, responding to new information, and preparing in advance for required activities.

(b) Workload distribution/Distraction avoidance. Issues involve proper allocation of tasks to individuals, avoidance of work overloads, prioritization of tasks during periods of high workload, and preventing nonessential factors from distracting attention from critical tasks.

(iv) Individual Factors. Training in this area can include defining and demonstrating individual characteristics that can influence crew effectiveness. Research has shown that many flightcrew members are unfamiliar with the negative effects of stress and fatigue on individual and team performance and cognitive functions. Training may include a review of scientific evidence on fatigue and stress effects including emergencies, personal and interpersonal problems and the increased importance of effective interpersonal communications under stressful conditions. It may also include familiarization with various countermeasures for coping with stressors. Additional curriculum topics could include examination of personality and motivational characteristics, self-assessment of personal styles, and cognitive factors influencing perception and decision processes.

10. Evolving Concepts of CRM.

a. Extending Training beyond the cockpit. Several air carriers have found it useful to extend CRM training both jointly and with cockpit crews to other operational groups. The goal of such training is to improve the effectiveness of these groups themselves and the quality of interactions between them and cockpit crews.

(1) Dispatchers share responsibility for the conduct of flight with captains under the FARS. Both must agree that the flight can be completed safely. Therefore, the need to understand the requirement for this communication and what to expect from it is the underlying reason for improved interactive training of pilots and dispatchers. The basic concepts of CRM provide a system to improve communication skills and awareness. The curriculum content and approaches of initial indoctrination, continuing

practice and feedback, and continuing reinforcement are relevant to dispatch operations.

(2) Cabin crews form part of the team responsible for every flight. The extension of CRM training to cabin crewmembers provides definition of team activities and skills needed to make interactions optimum in both normal and emergency situations.

(3) Maintenance activities are also team efforts that include interactions with the cockpit. CRM training for this group can enhance both the maintenance team itself and joint activities with flight crews.

b. Specialized Training in CRM Concepts. As CRM programs have matured, some organizations have found it advisable to develop and implement additional courses dealing with specific issues relevant to their operations.

(1) After all current crewmembers have completed the Initial Indoctrination/Awareness component of CRM training, provisions are needed to provide newly hired crewmembers with this background. A number of organizations have modified their initial course for presentation to new crewmembers as part of initial training and qualification.

(2) Training for upgrading to Captain also provides an opportunity for specialized training that deals with the human factors aspects of command. Such training can be incorporated in the upgrade process.

(3) A number of human factors issues related to the operation of advanced technology, highly automated aircraft have been identified by NASA and FAA sponsored research. Issues involving communications and the use of automation can be developed for crews operating these aircraft or transitioning into them.

11. ASSESSMENT OF CRM TRAINING PROGRAMS.

a. CRM training is a dynamic concept that will continue to be refined and improved. For this reason, it is vitally important that each program be assessed to determine whether it is achieving its stated goal, the improvement of flightcrew coordination and performance. Each organization should organize a systematic assessment program both as a means of tracking the effects of its training program and as a means of making continuous improvements and defining critical topics for recurrent training. Assessment of the *training program* should involve both observation of training process and self-reports of participants using standard survey methods.

The emphasis in this assessment process should be on crew performance. The major CRM areas of assessment should include communications processes and decision behavior, team building and maintenance, workload management and situational awareness along with traditional technical proficiency. An additional function of such assessment is to determine the impact of CRM training and organization wide trends in crew performance.

b. Reinforcement and feedback are essential for effective CRM training programs.

(1) Reinforcement is essential to operational impact. Crewmembers must receive continual reinforcement for the effective practice of CRM concepts. Effective reinforcement requires providing information to crewmembers on their human factors practices as well as technical performance.

(2) Specific feedback requires consistent assessment of crew performance to crewmembers on the human factors practices as well as technical performance. Crewmembers and those involved in training and evaluation should be able to recognize effective and ineffective human factors behaviors. **This does not imply that crewmembers should be formally evaluated and graded on the practice of CRM concepts, but rather that these issues should be incorporated in feedback and reinforcement of all aspects of training and operations.** The security and confidentiality of assessment data should be addressed in developing assessment plans. (See the FAA's CRM Handbook for discussion and guidelines.)

The emphasis in this assessment, process should be on *crew performance.* The major CRM areas of assessment should include communications processes and decision behavior, team building and maintenance, workload management and situational awareness, and as well as technical proficiency.

(3) An additional function of such assessment is to determine the impact of CRM training and to determine organization wide trends in crew performance.

(4) For optimal assessment, data on crewmember's CRM attitudes and behavior should be collected prior to the awareness phase of CRM training and again at intervals after training to determine both initial and enduring effects of t@e program. The goal should be to obtain an accurate picture of the state of the organization before formal adoption of this type of training and to continue to monitor the same elements after implementation.

c. In summary, assessment techniques should serve to:

(1) Measure the operational state of the organization.

(2) Determine topics in need of further emphasis or further instruction within the CRM program.

(3) Ensure that all check airmen and instructors are well prepared and standardized.

12. THE CRITICAL ROLE OF CHECK AIRMEN AND INSTRUCTORS.

a. The success of any CRM training program will ultimately depend on the skills of the personnel responsible for administering the training and observing/measuring its effects. Thus it is vitally important that CRM instructors (course facilitators), check pilots (operational reinforcers), and course designers (developers), be highly skilled in all areas related to the assessment and practice of CRM. It is important to note that these skills are different from and in addition to those associated with traditional flight instruction and checking.

b. Gaining proficiency and confidence in CRM instruction, observation, and measurement requires special training for instructors and check pilots in CRM training

methods such as role-playing simulations, systematic crew-centered observation, administering LOFT programs, and providing effective and helpful feedback to crews.

c. Instructors and check pilots also require additional training in observing crew performance for purposes of calibrating and standardizing their assessment and debriefing skills. This will help to ensure consistency and high quality, industry standards of performance.

d. In order to provide maximum learning for all crewmembers, instructors, simulator and line check personnel must use every available opportunity to emphasize the importance and use of crew coordination skills and techniques. This is accomplished best by having the crews examine their own performance and behavior, with the assistance of a trained instructor who can point out both positive and negative aspects of CRM performance. Whenever highly effective examples of crew coordination are observed, it is vital that these positive behaviors be discussed and reinforced. Debriefing and critique skills are important tools for instructors and check pilots to acquire and utilize.

e. Feedback from instructors and check airmen will be most effective if it reflects the concepts and behaviors that are covered in the initial indoctrination/awareness training and if the feedback refers to specific behaviors rather than vague generalities.

Appendix I
Crew Performance Marker Clusters
(Italicized Markers apply to Advanced Technology Flight decks)

These behavioral markers are provided to assist organizations in program and curriculum development and as guidelines for feedback. They not presented as a means of evaluating individual crewmembers.

A. Communications Processes and Decision Behavior

Briefing (conduct and quality). The effective briefing will be operationally thorough, interesting, and will address coordination, planning, and problems. [Although primarily a Captain responsibility, other crewmembers may add significantly to planning and definition of potential problem areas.]

Inquiry/Advocacy/Assertion. This rating assesses the extent to which crewmembers advocate the course of action they feel best, even when it involves conflict and disagreements with others.

Crew self-critique (decisions and actions). This item evaluates the extent to which crewmembers, conduct and participate in a debriefing, operational review, and critique of activities, which includes the product, the process, and the people involved. Critique can, and should, occur during an activity, and/or after completion of the activity.

Conflict resolution. If crewmembers engage in *conflict* while attempting to decide on a course of action or for any other reason, the effectiveness of means used to resolve the conflict and the use of available resources is rated.

Communications/Decisions. This rating reflects the extent to which free and open communication is practiced. It includes providing necessary information at the appropriate time (for example, initiating checklists, alerting others to developing problems). Active participation in decision making process encouraged and practiced. Questioning of actions and decisions is proper. Decisions made are clearly communicated and acknowledged.

1. Establishes team concept and environment for open/interactive communications (e.g., calls for questions or comments, answers questions directly, listens with patience, does not interrupt or "talk over", does not rush through the briefing, makes eye contact as appropriate).

2. Identifies potential problems such as weather, delays, and abnormal system operations. Sets expectations for how deviations from S.O.P. are to be handled

3. Provides guidelines for crew actions -- division of labor and crew workload addressed

4. Includes cabin crew as part of team in the briefing, as appropriate

5. Operational decisions are clearly stated to other crewmembers and acknowledged

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6. "Bottom lines" are established and communicated for safety of operations. The "big picture" and the game plan are shared within the team including flight attendants and others

7. Crewmembers are encouraged to state their own ideas, opinions, and recommendations

8. Crewmembers speak up, and state their information with appropriate persistence, until there is some clear resolution and decision

9. Crewmembers are encouraged to ask questions regarding crew actions and decisions and answers are provided openly and non defensively.

10. Critique is given at appropriate times, both low and high workload, and is made a positive learning experience for the whole crew -- feedback is specific, objective, based on observable behavior, and given constructively.

11. Critique is accepted objectively, and non defensively, deals with positive as well as negative aspects of crew performance.

12. When conflicts arise, the crew remains focused on the problem or situation at hand. Crewmembers listen actively to ideas and opinions and admit mistakes when wrong.

13. Assignment of blame is avoided -- the focus is on determining what is right, not who is right. Crewmembers treated with empathy and respect. When there is time, crewmembers explain "why" particular decisions were made.

14. Establishes policy guidelines for the operation of automated systems (i.e. when system will be disabled, programming actions that must be verbalized and acknowledged)

15. Specifies PF and PNF duties and responsibilities with regard to automated systems

16. Crewmembers verbalize and acknowledge entries and changes to automated systems

17. Crewmembers question status and programming of automated systems to verify and ensure situational awareness

B. Team Building and Maintenance

Leadership, Followership, & Concern for tasks. This rating evaluates the extent to which appropriate leadership and followership is practiced. It reflects the extent to which the crew is concerned with the effective accomplishment of necessary tasks.

Interpersonal relationships/Group climate. This evaluation reflects the quality of observed interpersonal relationships among and the overall *climate* of the flightdeck. This is independent of demonstrated concern with accomplishment of required tasks.

1. Coordinates flightdeck activities to establish proper balance between authority and assertiveness, acts decisively when the situation requires

2. Demonstrates desire to achieve most effective possible operation

3. Ensures that group climate is appropriate to operational situation (i.e. social conversation in low workload conditions but not high)

4. Shows sensitivity and ability to adapt to other crewmembers' personalities and personal characteristics

5. Recognizes symptoms of psychological stress and fatigue in self and others (e.g., note when a crewmember is not communicating, and draw him/her back into the team; recognize when they are experiencing "tunnel vision", and seek help from the team)

6. "Tone" in the cockpit is friendly, relaxed, supportive.

7. Ensures that non-operational factors such as social interaction do not interfere with necessary task duties

8. During times of low communication, crewmembers check in with each other to see how they are doing

9. *Recognizes and deals with demands on resources posed by operation of automated systems*

10. *Reverts to lower level of automation when programming demands could reduce situational awareness or create work overloads*

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C. Workload Management and Situational Awareness

Preparation/Planning/Vigilance. This rating indicates the extent to which crews anticipate contingencies and actions that may be required. Excellent crews are always "ahead of the curve" while poor crews continually play catch up. Vigilant crews devote appropriate attention to required tasks and respond immediately to new information. *A crew indulging in casual social conversation during periods of low workload is not necessarily lacking in vigilance if flight duties are being discharged properly.*

Workload distribution/Distraction avoidance. This is a rating of time and workload management. It reflects how well the crew managed to distribute the tasks and avoid overloading individuals. It also considers the ability of the crew to avoid being distracted from essential activities and how work is prioritized.

1. Actively monitors weather, aircraft systems, instruments and ATC communications, sharing relevant information with the rest of the crew

2. Avoids "tunnel vision", being aware of factors such as stress that can reduce vigilance -- thus, monitoring the performance of other crew members

3. Stays "ahead of curve" in preparing for expected or contingency situations (including approaches, weather, etc.)

4. Verbally insures that cockpit and cabin crew are aware of plans

5. Workload distribution is clearly communicated and acknowledged to maximize efficiency.

6. Ensures that secondary operational tasks (i.e. dealing with passenger needs, company communications) are prioritized so as to allow sufficient resources for dealing effectively with primary flight duties

7. Recognizes and reports overloads in self and others

8. *Plans for sufficient time prior to maneuvers for programming of automated systems*

9. *Ensures that all crewmembers are aware of status and changes in automated systems parameters*

10. *Crewmembers recognize potential distractions posed by automation and take appropriate preventive action, including reversion to lower levels of automation*

D. Overall Technical proficiency

This is a rating of how well the crew as a unit discharged the technical aspects of the flight. It reflects awareness that a high degree of technical proficiency is essential for safe and efficient operations. Demonstrated mastery of CRM concepts cannot overcome a lack of proficiency. Similarly, high technical proficiency cannot guarantee safe operations in the absence of effective crew coordination. This rating can be thought of as a more fine grained evaluation of the *technical* performance of a crew

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than the typical "S" or "U" employed in a Line Check or other evaluation. A "5" represents an unusual demonstration of proficiency while a "1" would reflect seriously substandard behavior. The typical well qualified crew would receive a "3".

1. Adheres to regulations and Air Traffic Control requirements, and follows company established procedures including checklist management and standard callouts.

2. Observes and effectively manages sterile cockpit environment.

3. Demonstrates a high level of basic (stick and rudder) flying skills .

4. Required briefings include all pertinent safety and operational issues as defined in relevant manuals

5. Demonstrates knowledge of aircraft systems and normal, abnormal, and emergency procedures

APPENDIX D:

Smith-Hamman Briefings

UNITED AIRLINES

Human Factors and Observable Behaviors
Crew Performance Workbook for
United Airlines Flight 723 LAS/LAX

This workbook is designed to assist the instructor in the difficult task of human factors observations of flight crewmembers. The design of the workbook is based on specific events integrated into the LOFT. These events were chosen based on their close correlation with our 1992 Safety theme and information from flight safety investigations.

Each phase of flight has a associated worksheet which highlights observable crew behaviors of our basic C/L/R principles. As a example when observing a briefing under the category of *Inquiry*, you may observe crewmembers are encouraged to state their own ideas. This would be noted on the worksheet by a time reference for possible discussion in the debriefing.

There are six phases of flight with events designed into the LOFT. However, these events should not prevent the instructor from using creativity to integrate other items which they feel are important. Additionally, as LOFT instructors we all have experienced the phenomenon that each LOFT and crew is different. Crews will create situations outside of this workbook which may result in excellent debriefing items. Thus, this workbook should not be considered as a limitation or boundary to the LOFT.

Human factors is a critical element of flight safety. The Airline Industry, ALPA, NASA and the scientific community are continuing to develop a data base of human factor crew interactions. The final sheet in the workbook is a summary sheet for the entire LOFT flight. please take a few minute to fill out your overall impression of this crew. This information is purely for data collection and will not be related to a individual crew.

PHASE OF FLIGHT – Predeparture Preflight

Events: Potential weather problems

a) Hot Day 90°F possible performance limit problem.

b) ATIS has several red flags to indicate possible windshear

c) Convective activity in area.

d) T procedure for runway 25.

PHASE OF FLIGHT: PREFLIGHT AND GROUND OPERATIONS
BRIEFING

COMMUNICATION DECISION MAKING	
INQUIRY	**Time**
Crewmembers are encouraged to ask questions regarding crew actions and decisions and answers are provided openly and nondefensively.	
Crewmembers actively seek information.	
ADVOCACY	
Crewmembers are encouraged to state their own ideas, opinions and recommendations.	
Active participation in decision process encouraged.	
CONFLICT RESOLUTION	
Conflicting and/or incomplete information is recognized and deal with effectively.	
DECISION MAKING	
Decision guidelines are provided.	
Operational decisions are clearly stated to other crewmembers and acknowledged.	
"Bottom lines" are established and communicated for safety of operations. The "big picture" and the game plan are shared within the team including flight attendants and others.	
CRITIQUE	
Initiates and/or participates in operational review which includes the outcome (product), the process and the people involved.	

TEAM BUILDING AND MAINTENANCE	
LEADERSHIP BRIEFING	**Time**
Coordinates flightdeck activities to establish proper balance between authority and assertiveness, acts decisively when the situation requires.	
Demonstrates desire to achieve most effective possible operation.	
Establishes team concept and environment for open/interactive communications (e.g., calls for questions or comments, answers questions directly, listens with patience, does not interrupt or "talk over", does not rush through the briefing, makes eye contact as appropriate).	
"Tone" in the cockpit is friendly, relaxed, supportive.	
Notes when a crewmember is not communicating and draw him/her back into the team.	
Identifies potential problems such as weather, delays and abnormal system operations. Sets expectations for how deviations from S.O.P. are to be handled.	
Provides guidelines for crew actions - division of labor and crew workload addressed.	
Includes cabin crew as part of team in the briefing, as appropriate.	
Specifies PF and PNF duties and responsibilities with regard to automation.	

WORKLOAD MANAGEMENT AND SITUATIONAL AWARENESS	
WORKLOAD MANAGEMENT	**Time**
Information is prioritized consistent with the operational situation.	
Workload is managed to maximize crew efficiency.	
Time is managed to optimize crew performance.	
Verbally insures that cockpit and cabin crew are aware of plans.	
SITUATIONAL AWARENESS	
Climate, traffic and terrain are enduring components of the mental model.	
Conflicts and "red flags" are quickly recognized and resolved.	

PHASE OF FLIGHT – Ground Operation Taxi

Events:

a) Another United aircraft with a similar flight number is taxiing to Runway 25L with the potential for accepting the wrong clearance when cleared into position.

b) ATC background information is verifying there is windshear in the area.

c) Other specific aircraft items which instructor integrates during taxi.

PHASE OF FLIGHT: GROUND OPERATIONS
TAXI

COMMUNICATION DECISION MAKING	
INQUIRY	**Time**
Crewmembers actively seek information.	
ADVOCACY	
Crewmembers speak up and state their information with appropriate persistence, until there is some clear resolution and decision.	
Crewmembers verifies partner received information.	
CONFLICT RLSOLUTION	
Conflicting and/or incomplete information is recognized and dealt with effectively.	
When conflicts arise, the crew remains focused on the problem or situation at hand. Crewmembers listen actively to ideas and opinions and admit mistakes when wrong.	
DECISION MAKING	
Providing information at appropriate time.	
Active participation in decision process encouraged.	
Decision guidelines are provided.	
Operational decisions are clearly stated to other crewmembers and acknowledged.	
"Bottom lines" are established and communicated for safety of operations. The "big picture" and the game plan are shared within the team including flight attendants and others.	
Crewmembers are encouraged to ask questions regarding crew actions and decisions and answers are provided openly and nondefensively.	

COMMUNICATION DECISION MAKING (continued)	
CREW SELF CRITIQUE	**Time**
Critique is given at appropriate times, both low and high workload and is made a positive learning experience for the whole crew - feedback is specific, objective, based on observable behavior and given constructively.	

TEAM BUILDING AND MAINTENANCE	
LEADERSHIP BRIEFING	**Time**
Ensures that non-operational factors such as social interaction do not interfere with necessary task duties.	
Demonstrates desire to achieve most effective possible operation.	
Coordinates flightdeck activities to establish proper balance between authority and assertiveness, acts decisively when the situation requires.	

WORKLOAD MANAGEMENT AND SITUATIONAL AWARENESS	
WORKLOAD MANAGEMENT	**Time**
Stays "ahead of curve" in preparing for expected or contingency situations (including approaches, weather)	
Workload distribution is clearly communicated and acknowledged to maximize efficiency.	
SITUATIONAL AWARENESS	
Actively monitors weather, aircraft systems, instruments and ATC communications, sharing relevant information with the rest of the crew.	
Verbally insures that cockpit and cabin crew are aware of plans.	
Climate, traffic and terrain are enduring components of the mental model.	
Conflicts and "red flags" are quickly recognized and resolved.	
Crewmembers question status and programing of automation to verify and ensure situational awareness.	
Ensure that *all crewmembers are aware of* status and changes in automation parameters.	

PHASE OF FLIGHT – Takeoff

Event: a) Near or at V_1 a minor system problem will be given to evaluate the crews GO/NO GO decision, as well as the addition of a distraction to the takeoff maneuver.

PHASE OF FLIGHT: TAKE OFF

COMMUNICATION DECISION MAKING	
INQUIRY	**Time**
Crewmembers actively seek information.	
ADVOCACY	
Crewmembers speak up and state their information with appropriate persistence, until there is some clear resolution and decision.	
Crewmembers verifies partner received information.	
CONFLICT RESOLUTION	
Conflicting and/or incomplete information is recognized and dealt with effectively.	
DECISION MAKING	
Operational decisions are clearly stated to other crewmembers and acknowledged.	
CRITIQUE	
Initiates and/or participates in operational review which includes the outcome (product), the process and the people involved.	

TEAM BUILDING AND MAINTENANCE	
LEADERSHIP BRIEFING	**Time**
Coordinates flightdeck activities to establish *proper* balance between authority and assertiveness, acts decisively when the situation requires.	

WORKLOAD MANAGEMENT AND SITUATIONAL AWARENESS	
WORKLOAD MANAGEMENT	**Time**
Time is managed to optimize crew performance.	
Ensures that secondary operational tasks (i.e., dealing with passenger needs, company communications) are prioritized so as to allow sufficient resources for dealing effectively with primary flight duties.	
Recognizes and reports overloads in self and others.	
SITUATIONAL AWARENESS	
Avoids "tunnel vision", being aware of factors such as stress that can reduce vigilance - thus, monitoring the performance of other crewmembers.	
Climate, traffic and terrain are enduring components of the mental model.	
Conflicts and "red flags" are quickly recognized and resolved.	
Ensure that all crewmembers are aware of status and changes in automation parameters.	

PHASE OF FLIGHT – Initial Climb and Intermediate Level Off

Events:

a) Continuation and completion of problem which developed at V1.

b) Convective activity in the area of Oasis intersection which results in a vector to the West.

c) Turbulence reports in the climb out of LAS.

d) Busy ATC system which results in the aircraft being held at 7000'.

e) High SAT which may result in performance problems in meeting minimum sector altitudes when a climb is initiated.

f) Variable events which instructors integrate into this flight segment.

PHASE OF FLIGHT: INITIAL CLIMB AND INTERMEDIATE LEVEL OFF

COMMUNICATION DECISION MAKING	
INQUIRY	**Time**
Crewmembers actively seek information.	
ADVOCACY	
Crewmembers speak up and state their information with appropriate persistence, until there is some clear resolution and decision.	
Crewmember verifies partner received information.	
CONFLICT RESOLUTION	
Conflicting and/or incomplete information is recognized and dealt with effectively.	
When conflicts arise, the crew remains focused on the problem or situation at hand. Crewmembers listen actively to ideas and opinions and admit mistakes when wrong.	
DECISION MAKING	
Operational decisions are clearly stated to other crewmembers and acknowledged.	
CRITIQUE	
Initiates and/or participates in operational review which includes the outcome (product), the process and the people involved.	

TEAM BUILDING AND MAINTENANCE	
LEADERSHIP BRIEFING	**Time**
Recognizes symptoms of psychological stress and fatigue in self and others (e.g., note when a crewmember is not communicating and draw him/her back into the team; recognize when they are experiencing "tunnel vision" and seek help from the team).	
Coordinates flightdeck activities to establish proper balance between authority and assertiveness, acts decisively when the situation requires.	

WORKLOAD MANAGEMENT AND SITUATIONAL AWARENESS	
WORKLOAD MANAGEMENT	**Time**
Workload distribution is clearly communicated and acknowledged to maximize efficiency.	
Stays "ahead of curve" in preparing for expected or contingency situations (including approaches, weather).	
Ensures that secondary operational tasks (i.e., dealing with passenger needs, company communications) are prioritized so as to allow sufficient resources for dealing effectively with primary flight duties.	
Recognizes and reports overloads in self and others.	

WORKLOAD MANAGEMENT AND SITUATIONAL AWARENESS (continued)	
SITUATIONAL AWARENESS	**Time**
Actively monitors weather, aircraft systems, instruments and ATC communications, sharing relevant information with the rest of the crew.	
Avoids "tunnel vision", being aware of factors such as stress that can reduce vigilance - thus, monitoring the performance of other crewmembers.	
Climate, traffic and terrain are enduring components of the mental model.	
Information is prioritized consistent with the operational situation.	
Conflicts and "red flags" are quickly recognized and resolved.	
Crewmembers question status and programing of automation to verify and ensure situational awareness.	
Ensure that all crewmembers are aware of status and changes in automation parameters.	

PHASE OF FLIGHT – Climb and Cruise

Events:

a) Poor climb performance and turbulence may continue to be a problem during climb and cruise.

b) Aircraft specific events which may be integrated into the LOFT during this phase of flight.

PHASE OF FLIGHT: CONTINUED CLIMB AND CRUISE

COMMUNICATION DECISION MAKING	
INQUIRY	**Time**
Crewmembers actively seek information.	
ADVOCACY	
Crewmembers speak up and state their information with appropriate persistence, until there is some clear resolution and decision.	
Crewmember verifies partner received information.	
Crewmembers verbalize and acknowledge entries and changes to flight automation.	
CONFLICT RESOLUTION	
Conflicting and/or incomplete information is recognized and dealt with effectively.	
When conflicts arise, the crew remains focused on the problem or situation at hand. Crewmembers listen actively to ideas and opinions and admit mistakes when wrong.	
DECISION MAKING	
Operational decisions are clearly stated to other crewmembers and acknowledged.	
Crewmembers are encouraged to ask questions regarding crew actions and decisions and answers are provided openly and nondefensively.	
CRITIQUE	
Initiates and/or participates in operational review which includes the outcome (product), the process and the people involved.	

TEAM BUILDING AND MAINTENANCE	
LEADERSHIP BRIEFING	**Time**
Ensures that group climate is appropriate *to operational situation (i.e., social* conversation in low workload conditions but not high).	
Shows sensitivity and ability to adapt to other crewmembers' personalities and personal characteristics.	
Ensures that non-operational factors such as social interaction do not interfere with necessary task duties.	
During times of low communication, crewmembers check in with each other to see how they are doing.	

WORKLOAD MANAGEMENT AND SITUATIONAL AWARENESS	
WORKLOAD MANAGEMENT	**Time**
Stays "ahead of curve" in preparing for *expected or contingency situations* (including approaches, weather).	
SITUATIONAL AWARENESS	
Actively *monitors weather, aircraft systems,* instruments and ATC communications, sharing relevant information with the rest of the crew.	
Information is prioritized consistent with the operational situation.	
Conflicts and "red flags" are quickly recognized and resolved.	
Ensure that all crewmembers are aware of status and changes in automation parameters.	

PHASE OF FLIGHT – Descent

Events:

a) Prior to top of descent, crew will be given a distraction problem. Instructors should choose a event which will require interaction with the flight attendants, i.e., sick passenger, turbulence inquiry, smoke in cabin, etc.

b) Descent clearance should be delayed into a area where the crew should realize the descent performance of their aircraft will not allow compliance with the Civet profile descent.

c) When the descent clearance is given it should be a stepped compound clearance. As an example, "*United 723 descent to and maintain* flight level two zero zero expect to cross Civet intersection at flight level one eight zero. After the aircraft levels off at flight level two zero zero the aircraft should be cleared for the Civet profile descent.

d) The weather at LAX should be marginal VFR because of haze and fog and should contain red flags to indicate the possibility of further deterioration.

PHASE OF FLIGHT: DESCENT

COMMUNICATION DECISION MAKING	
INQUIRY	Time
Crewmembers actively seek information.	
Crewmembers are encouraged to ask questions regarding crew actions and decisions and answers are provided openly and nondefensively.	
ADVOCACY	
Crewmembers are encouraged to state their own ideas, opinions and recommendations.	
Crewmembers speak up and state their information with appropriate persistence, until there is some clear resolution and decision.	
Crewmember verifies partner received information.	
CONFLICT RESOLUTION	
When conflicts arise, the crew remains focused on the problem or situation at hand. Crewmembers listen actively to ideas and opinions and admit mistakes when wrong.	
Conflicting and/or incomplete information is recognized and dealt with effectively.	
DECISION MAKING	
Operational decisions are clearly stated to other crewmembers and acknowledged.	
Providing information at appropriate time.	
"Bottom lines" are established and communicated for safety of operations. The "big picture" and the game plan are shared with the team including flight attendants and others.	

COMMUNICATION DECISION MAKING (continued)	
CRITIQUE	Time
Critique is given at appropriate times, both low and high workload and is made a positive learning experience for the whole crew - feedback is specific, objective, based on observable behavior and given constructively.	

TEAM BUILDING AND MAINTENANCE	
LEADERSHIP BRIEFING	Time
Ensures that non-operational factors such as social interaction do not interfere with necessary task duties.	
Coordinates flightdeck activities to establish proper balance between authority and assertiveness, acts decisively when the situation requires.	
Recognizes symptoms of psychological stress and fatigue in self and others (e.g., note when a crewmember is not communicating and draw him/her back into the team; recognize when they are experiencing "tunnel vision" and seek help from the team).	
Identifies potential problems such as weather, delays and abnormal system operations. Sets expectations for how deviations from S.O.P. are to be handled.	
Establishes policy guidelines for the operation of automated systems (i.e., when system will be disabled, programming actions that must be verbalized and acknowledged).	

WORKLOAD MANAGEMENT AND SITUATIONAL AWARENESS	
WORKLOAD MANAGEMENT	Time
Ensures that secondary operational tasks (i.e., dealing with passenger needs, company communications) are prioritized so as to allow sufficient resources for dealing effectively with primary flight duties.	
Workload distribution is clearly communicated and acknowledged to maximize efficiency.	
Stays "ahead of curve" in preparing for expected or contingency situations (including approaches, weather).	
Recognizes and reports overloads in self and others.	
SITUATIONAL AWARENESS	
Conflicts and "red flags" are quickly recognized and resolved.	
Actively monitors weather, aircraft systems, instruments and ATC communications, sharing relevant information with the rest of the crew.	
Avoids "tunnel vision", being aware of factors such as stress that can reduce vigilance - thus, monitoring the performance of other crewmembers.	
Climate, traffic and terrain are enduring components of the mental model.	
Crewmembers question status and programing of automation to verify and ensure situational awareness.	
Ensure that all crewmembers are aware of status and changes in automation parameters.	

PHASE OF FLIGHT – Descent

Event:

a) Crew will be in very high workload environment of the Civet profile descent. The aircraft will continue to be high on the profile unless the crew intervenes.

b) The LAX weather will deteriorate which should necessitate a complete approach briefing.

c) A runway change should be given to create the situation of a possible wrong frequency for the ILS being selected, and to increase the workload.

PHASE OF FLIGHT: FINAL DESCENT

COMMUNICATION DECISION MAKING	
INQUIRY	Time
Crewmembers actively seek information.	
ADVOCACY	
Crewmembers speak up and state their information with appropriate persistence, until there is some clear resolution and decision.	
Crewmember verifies partner received information.	
Crewmembers verbalize and acknowledge entries and changes to flight automation.	
CONFLICT RESOLUTION	
When conflicts arise, the crew remains focused on the problem or situation at hand. Crewmembers listen actively to ideas and opinions and admit mistakes when wrong.	
DECISION MAKING	
"Bottom lines" are established and communicated for safety of operations. The "big picture" and the game plan are shared within the team including flight attendants and others.	
Operational decisions are clearly stated to other crewmembers and acknowledged.	
CRITIQUE	
Initiates and/or participates in operational review which includes the outcome (product), the process and the people involved.	

TEAM BUILDING AND MAINTENANCE	
LEADERSHIP BRIEFING	Time
Provides guidelines for crew actions - division of labor and crew workload addressed.	
Recognizes symptoms of psychological stress and fatigue in self and others (e.g., note when a crewmember is not communicating and draw him/her back into the team; recognize when they are experiencing "tunnel vision" and seek help from the team).	
Identifies potential problems such as weather, delays and abnormal system operations. Sets expectations for how deviations from S.O.P. are to be handled.	

WORKLOAD MANAGEMENT AND SITUATIONAL AWARENESS	
WORKLOAD MANAGEMENT	Time
Workload distribution is clearly communicated and acknowledged to maximize efficiency.	
Stays "ahead of curve" in preparing for expected or contingency situations (including approaches, weather).	
Recognizes and reports overloads in self and others.	
SITUATIONAL AWARENESS	
Conflicts and "red flags" are quickly recognized and resolved.	
Climate, traffic and terrain are enduring components of the mental model.	
Avoids "tunnel vision", being aware of factors such as stress that can reduce vigilance - thus, monitoring the performance of other crewmembers.	
Crewmembers question status and programing of automation to verify and ensure situational awareness.	
Ensure that all crewmembers are aware of status and changes in automation parameters.	

UNITED AIRLINES

HUMAN FACTOR/TECHNICAL TRAINING MODULE
CRITICAL FLIGHT MANEUVER

PERFORM TAKEOFF

WITH

ENGINE FAILURE AT V1

AT

ABQ

RUNWAY 8 ("t")

PREPARED BY,

KEVIN M. SMITH

WILLIAM HAMMAN

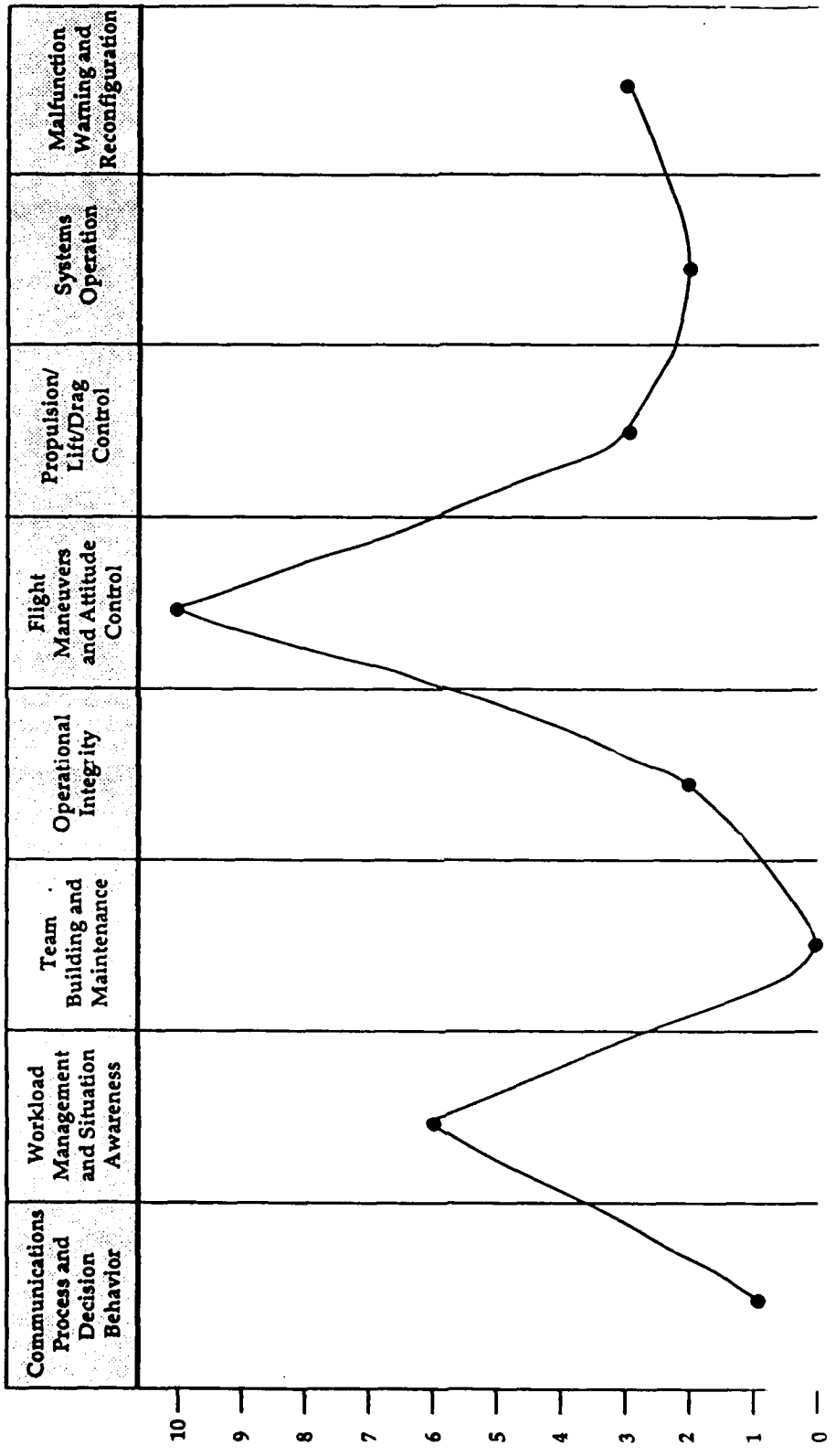
AUGUST 1991

CRM INTEGRATION

FUNCTION / TASK	Crew Performance/Human Factors				Crew Performance/ Technical			
3.1. Perform Takeoff with Engine Failure at V1	Communications Process & Decision Behavior	Workload Management & Situation Awareness	Team Building & Maintenance	Operational Integrity	Flight Maneuvers & Attitude Control	Propulsion/ Lift/Drag Control	Systems Operation	Malfunction Warning & Reconfiguration
3.1.1. Monitor/assess Environmental Factors	A132	C71 C74		D13			G1	H1
3.1.2. Perform Takeoff Roll After Engine Failure		C72		D12	E1 E3	F1 F3		
3.1.3. Evaluate Single Engine Takeoff Criteria					E3 E8			H1 H2
3.1.4. Perform SE Rotation/Liftoff		C82 C812			E6 E7 E1 E8 E5	F2	G3	
3.1.5. Perform Communications		C75						

INSTRUCTIONAL EMPHASIS

TASK: 3.1. PERFORM TAKE OFF WITH ENGINE FAILURE AT V1



PERFORM CREW FUNCTIONS DURING TAKEOFF - V1 CUT

Complex, interactive function performed under increased time compression. Avoidance of catastrophe a major concern. Key components of the function involve:

C: Workload management and situation awareness

E: Flight maneuvers and attitude control

Other significant functions:

D: Operational integrity

F: Propulsion/lift/drag control

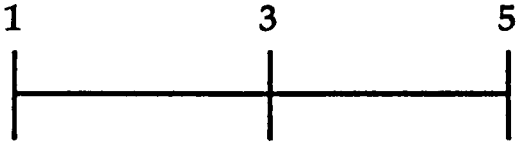
MISSION PHASE: PRIOR TO PUSH BACK

TASK OBJECTIVE: PERFORM TAKEOFF BRIEFING

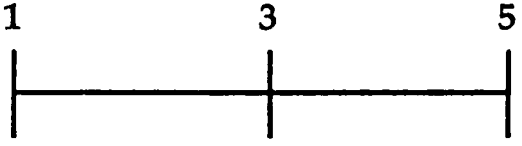
PF (Captain)	PNF (First Officer)
1) Takeoff briefing to include "t" procedure ☐	1) Active participation in takeoff briefing ☐
2) Acknowledgement of terrain and location ☐	
3) Special items highlighted ☐	

CREW PERFORMANCE MARKERS

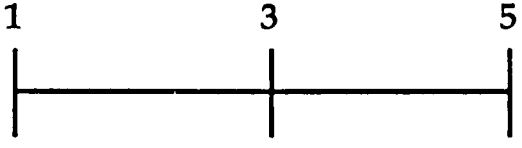
A1.1. Identifies potential problems such as weather, delays, terrain, and special contingencies.



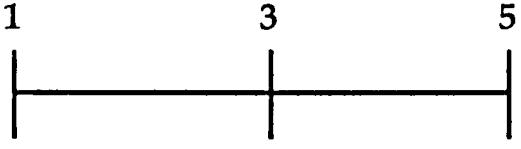
A1.2. Provides guidelines for crew action - division of labor and workload addressed.



A1.5. Specifies PNF duties with regard to automation.



A1.7. Plan addresses consideration of risk.



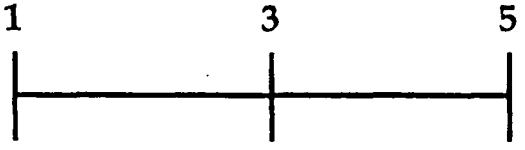
MISSION PHASE: BRAKE RELEASE TO ROTATION

TASK OBJECTIVE: PERFORM TAKEOFF ROLL WITH ENGINE FAILURE AT V1

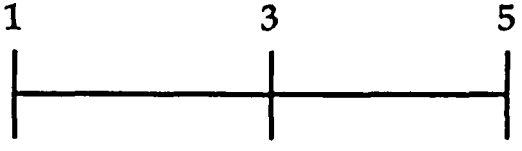
PF	PNF
1) Timely recognition of yaw and establish directional control prior to rotation ☐	1) Call out engine failure ☐
	2) Monitor tracking performance and announce excessive drift ☐

CREW PERFORMANCE MARKERS

E1. Properly interpret control and performance instruments during takeoff roll



F1. Proper and timely interpretation of propulsion information



MISSION PHASE: ROTATION TO 500' AGL

TASK OBJECTIVE: ROTATE AND CLIMB TO OPTIMIZE AIRCRAFT PERFORMANCE AFTER ENGINE FAILURE AT V1 WHILE MAINTAINING DIRECTIONAL CONTROL

PF	PNF
1) Rotate to establish initial climb profile: • 13° ANU • V2-V2+20 ☐	1) Recognize and announce marginal climb performance ☐
2) Positive climb gear up ☐	2) Retract gear on command ☐
3) Maintain wings level and directional control to 400' (minimize drift) ☐	3) Activate heading select at 400' - confirm ADI annunciation ☐
4) At 400' announce heading select ☐	4) Set/confirm heading to ABQ VOR ☐
5) Initiate right turn at 400' (5750 AGL) ☐	5) Confirm 15° AOB ☐

MISSION PHASE: ROTATION TO 500' AGL (continued)

TASK OBJECTIVE: ROTATE AND CLIMB TO OPTIMIZE AIRCRAFT PERFORMANCE AFTER ENGINE FAILURE AT V1 WHILE MAINTAINING DIRECTIONAL CONTROL

PF

6) Disconnect autothrottle at 400' ☐

7) Initiate level off at 500' AGL while maintaining a right turn (15°<) to ABQ: ☐

- Announce autothrottle - off
- Altitude - hold
- Airspeed - 210 kts.
- Check flaps - 1

(Fight the fire)

PNF

6) Confirm autothrottle disconnect ☐

7) Select altitude hold ☐

8) Set airspeed 210 kts. ☐

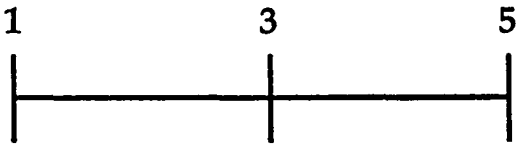
9) Check flaps 1 ☐

10) Fight the fire if appropriate: ☐

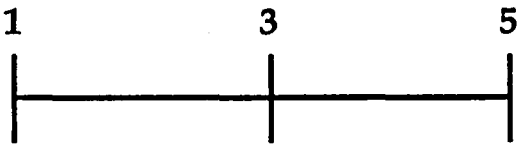
- Throttle idle
- Start lever confirm cutoff
- Fire handle pull

CREW PERFORMANCE MARKERS

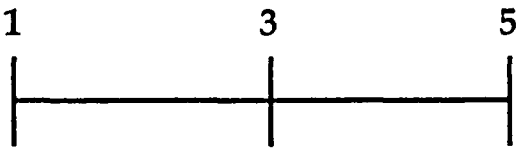
C8.1. Workload is managed and activities are coordinated to maximize efficiency



C74. Awareness of terrain is maintained throughout the maneuver

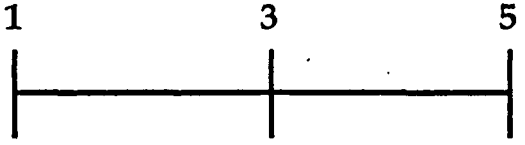


C72. Avoid focusing on one factor (tunnel vision) - prompt initiation of turn at 400' AGL and maintain positive turn performance most critical factor. 500' level off less critical than maintaining positive turn performance to avoid steeply rising terrain.

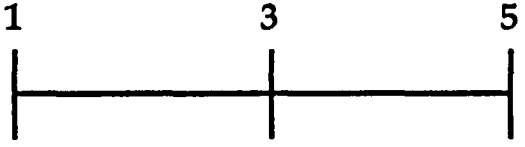


CREW PERFORMANCE MARKERS

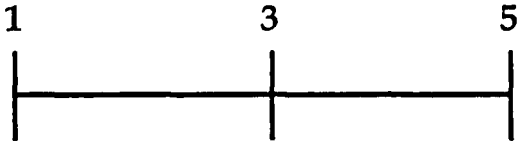
E3. Maintain runway alignment/directional control during initial climb (+10°)



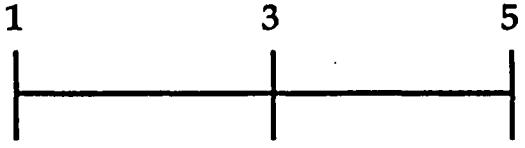
E6. Establish optimum climb performance to 500' AGL (V2-V2+20)



E7. Maintain "in trim" - minimize cross control to optimize climb performance



F3. Ensure optimum power is utilized during initial climb (if reduced takeoff power was used)

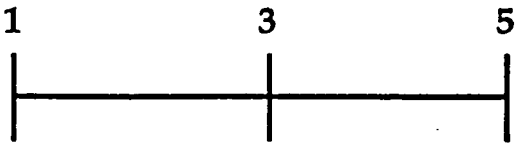


MISSION PHASE:	ACCELERATION AT 500' AGL TO SECOND SEGMENT CLIMB
TASK OBJECTIVE:	ACCELERATE TO 210 KTS. AT 500' AGL AND NAVIGATE TO ABQ VOR

PF		PNF	
1) Notify tower of emergency	☐	1) Confirm heading to ABQ VDR	☐
2) Call for flaps up at clean maneuvering speed	☐	2) Confirm ABQ as active way point	☐
3) Perform LNAV to ABQ	☐	3) Select LNAV to ABQ	☐
4) At 210 kts: • Level change • Maximum continuous thrust • After takeoff checklist • Assess the engine	☐	4) Select flaps up on command	☐
		5) Select level change on MCP - confirm missed approach altitude	☐
		6) Set maximum continuous thrust	☐

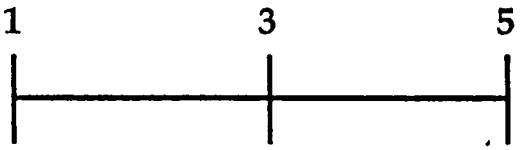
CREW PERFORMANCE MARKERS

C84. **Workload distribution is clearly communicated and acknowledged to maximize efficiency:**



- PF handles ATC
- PNF checklist
- PNF MCP
- PF Cabin

D13. Manage risk: Project state/condition of aircraft to desired outcome. Reduce risk as much as possible:



- Turn performance critical
- 500' level off should not be done at expense of turn performance

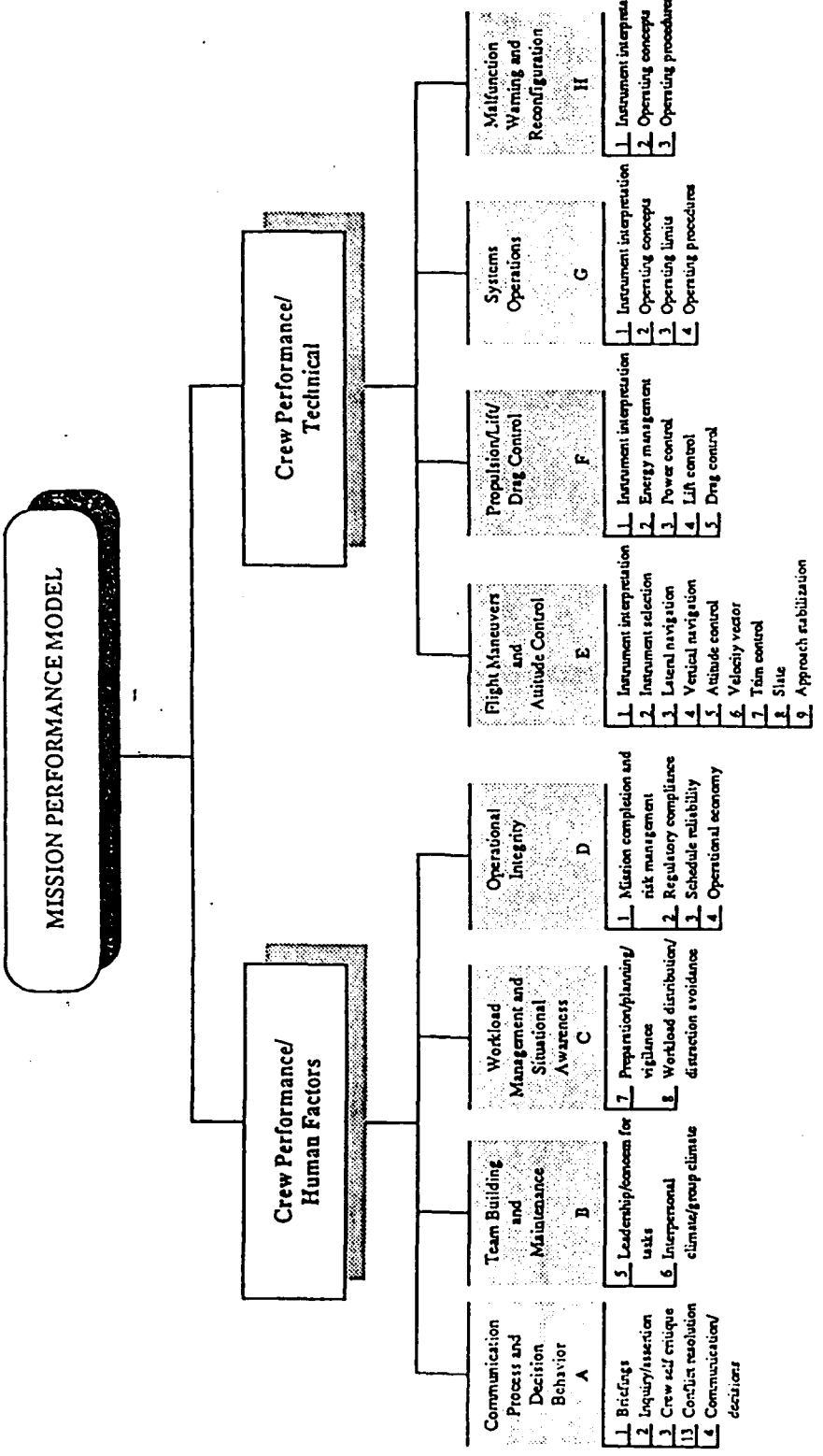

MISSION PERFORMANCE MODEL
Crew Performance/ Human Factors
Crew Performance/ Technical
Communication Process and Decision Behavior A
1 Briefings
2 Inquiry/assertion
3 Crew self critique
13 Conflict resolution
4 Communication/ decisions
Team Building and Maintenance B
5 Leadership/concern for tasks
6 Interpersonal climate/group climate
Workload Management and Situational Awareness C
7 Preparation/planning/ vigilance
8 Workload distribution/ distraction avoidance
Operational Integrity D
1 Mission completion and risk management
2 Regulatory compliance
3 Schedule reliability
4 Operational economy
Flight Maneuvers and Attitude Control E
1 Instrument interpretation
2 Instrument selection
3 Lateral navigation
4 Vertical navigation
5 Attitude control
6 Velocity vector
7 Trim control
8 Slips
9 Approach stabilization
Propulsion/Lift/ Drag Control F
1 Instrument interpretation
2 Energy management
3 Power control
4 Lift control
5 Drag control
Systems Operations G
1 Instrument interpretation
2 Operating concepts
3 Operating limits
4 Operating procedures
Malfunction Warning and Reconfiguration H
1 Instrument interpretation
2 Operating concepts
3 Operating procedures

Figure 1

CREW PERFORMANCE MARKERS

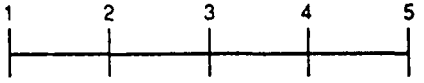
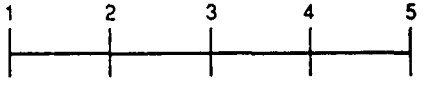
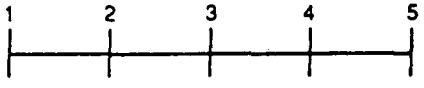
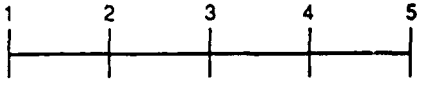
Revision A (4/18/91)

CLUSTER	CATEGORY	MARKER	ASSESSMENT
A: Communications Process and Decision Behavior	1: Briefing *The effective briefing will be operationally thorough, interesting, and will address coordination, planning, and problems. [Although primarily a Captain responsibility, other crewmembers may add significantly to planning and definition of potential problem areas.]*	1) Identifies potential problems such as weather, delays and abnormal system operations. Sets expectations for how deviations from S.O.P. are to be handled.	1 2 3 4 5
		2) Provides guidelines for crew actions - division of labor and crew workload addressed.	1 2 3 4 5
		3) Includes cabin crew as part of team in the briefing, as appropriate.	1 2 3 4 5
		4) Establishes policy guidelines for the operation of automated systems (i.e., when system will be disabled, programming actions that must be verbalized and acknowledged).	1 2 3 4 5
		5) Specifies PF and PNF duties and responsibilities with regard to automation.	1 2 3 4 5
		6) Plan factors in potential problems.	1 2 3 4 5
		7) Plan addresses considerations of risk.	1 2 3 4 5

1	2	3	4	5
Poor Performance Significantly Below Expectations	Minimally Acceptable Performance Improvement Needed	Satisfactory or Standard Performance	Very Good, Above Average Performance	Exceptional Performance Significantly Above Standard

CREW PERFORMANCE MARKERS

Revision A (4/18/91)

CLUSTER	CATEGORY	MARKER	ASSESSMENT
A: Communications Process and Decision Behavior	2: Inquiry Advocacy Assertion *This rating assesses the extent to which crewmembers advocate the course of action they feel best, even when it involves conflict and disagreements with others.*	1) Crewmembers are encouraged to state their own ideas, opinions and recommendations.	
		2) Crewmembers speak up and state their information with appropriate persistence, until there is some clear resolution and decision.	
		3) Crewmembers actively seek information.	
		4) Crewmembers verifies partner received information.	
		5) Crewmembers verbalize and acknowledge entries and changes to flight automation.	

1	2	3	4	5
Poor Performance Significantly Below Expectations	Minimally Acceptable Performance Improvement Needed	Satisfactory or Standard Performance	Very Good, Above Average Performance	Exceptional Performance Significantly Above Standard

CREW PERFORMANCE MARKERS

Revision A (4/18/91)

CLUSTER	CATEGORY	MARKER	ASSESSMENT
A: Communications Process and Decision Behavior	**3: Crew Self Critique** *This item evaluates the extent to which crewmembers conduct and participate in a debriefing, operational review, and critique of activities, which includes the product, the process, and the people involved. Critique can, and should, occur during an activity, and/or after completion of the activity.*	1) Critique is given at appropriate times, both low and high workload and is made a positive learning experience for the whole crew - feedback is specific, objective, based on observable behavior and given constructively.	1 2 3 4 5
		2) Critique is accepted objectively and nondefensively, deals with positive as well as negative aspects of crew performance.	1 2 3 4 5
		3) Assignment of blame is avoided - the focus is on determining what is right, not who is right. Crewmembers treated with empathy and respect. When there is time, crewmembers explain "why" particular decisions were made.	1 2 3 4 5
		4) Initiates and/or participates in operational review which includes the outcome (product), the process and the people involved.	1 2 3 4 5

1	2	3	4	5
Poor Performance Significantly Below Expectations	Minimally Acceptable Performance Improvement Needed	Satisfactory or Standard Performance	Very Good, Above Average Performance	Exceptional Performance Significantly Above Standard

CREW PERFORMANCE MARKERS

Revision A (4/18/91)

CLUSTER	CATEGORY	MARKER	ASSESSMENT
A: Communications Process and Decision Behavior	4: Communications/ Decision *This rating reflects the extent to which free and open communication is practiced. It includes providing necessary information at the appropriate time (for example, initiating checklists, alerting others to developing problems). Active participation in decision making process encouraged and practices. Questioning of actions and decisions is proper. Decisions made are clearly communicated and acknowledged.*	1) Providing information at appropriate time.	1 2 3 4 5
		2) Active participation in decision process encouraged.	1 2 3 4 5
		3) Decision guidelines are provided.	1 2 3 4 5
		4) Operational decisions are clearly stated to other crewmembers and acknowledged.	1 2 3 4 5
		5) "Bottom lines" are established and communicated for safety of operations. The "big picture" and the game plan are shared within the team including flight attendants and others.	1 2 3 4 5
		6) Crewmembers are encouraged to ask questions regarding crew actions and decisions and answers are provided openly and nondefensively.	1 2 3 4 5

1	2	3	4	5
Poor Performance Significantly Below Expectations	Minimally Acceptable Performance Improvement Needed	Satisfactory or Standard Performance	Very Good, Above Average Performance	Exceptional Performance Significantly Above Standard

CREW PERFORMANCE MARKERS

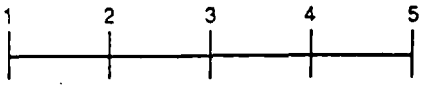
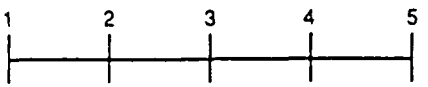
Revision A (4/18/91)

CLUSTER	CATEGORY	MARKER	ASSESSMENT
A: Communications Process and Decision Behavior	**13: Conflict Resolution** *If crewmembers engage in conflict while attempting to decide on a course of action or for any other reason, the effectiveness of means used to resolve the conflict and the use of available resources is rated.*	1) When conflicts arise, the crew remains focused on the problem or situation at hand. Crewmembers listen actively to ideas and opinions and admit mistakes when wrong. 2) Conflicting and/or incomplete information is recognized and dealt with effectively.	1 2 3 4 5 1 2 3 4 5

1	2	3	4	5
Poor Performance Significantly Below Expectations	**Minimally Acceptable Performance Improvement Needed**	**Satisfactory or Standard Performance**	**Very Good, Above Average Performance**	**Exceptional Performance Significantly Above Standard**

CREW PERFORMANCE MARKERS

Revision A (4/18/91)

CLUSTER	CATEGORY	MARKER	ASSESSMENT
B: Team Building and Maintenance	5: Leadership, Followership and Concern for Tasks *This rating evaluates the extent to which appropriate leadership and followership is practiced. It reflects the extent to which the crew is concerned with the effective accomplishment of necessary tasks.*	1) Ensures that non-operational factors such as social interaction do not interfere with necessary task duties.	
		2) During times of low communication, crewmembers check in with each other to see how they are doing.	
		3) Demonstrates desire to achieve most effective possible operation.	
		4) Coordinates flightdeck activities to establish proper balance between authority and assertiveness, acts decisively when the situation requires.	

1	2	3	4	5
Poor Performance Significantly Below Expectations	Minimally Acceptable Performance Improvement Needed	Satisfactory or Standard Performance	Very Good, Above Average Performance	Exceptional Performance Significantly Above Standard

CREW PERFORMANCE MARKERS

Revision A (4/18/91)

CLUSTER	CATEGORY	MARKER	ASSESSMENT
B: Team Building and Maintenance	**6: Interpersonal Relations/Group Climate** *This evaluation reflects the quality of observed interpersonal relationships among and the overall climate of the flightdeck. This is independent of demonstrated concern with accomplishment of required tasks.*	1) Establishes team concept and environment for open/interactive communications (e.g., calls for questions or comments, answers questions directly, listens with patience, does not interrupt or "talk over", does not rush through the briefing, makes eye contact as appropriate.	1 2 3 4 5
		2) "Tone" in the cockpit is friendly, relaxed, supportive.	1 2 3 4 5
		3) Ensures that group climate is appropriate to operational situation (i.e., social conversation in low workload conditions but not high).	1 2 3 4 5
		4) Shows sensitivity and ability to adapt to other crewmembers' personalities and personal characteristics.	1 2 3 4 5
		5) Recognizes symptoms of psychological stress and fatigue in self and others (e.g., note when a crewmember is not communicating and draw him/her back into the team; recognize when they are experiencing "tunnel vision" and seek help from the team).	1 2 3 4 5

1	2	3	4	5
Poor Performance Significantly Below Expectations	Minimally Acceptable Performance Improvement Needed	Satisfactory or Standard Performance	Very Good, Above Average Performance	Exceptional Performance Significantly Above Standard

CREW PERFORMANCE MARKERS

Revision A (4/18/91)

CLUSTER	CATEGORY	MARKER	ASSESSMENT
C: Workload Management and Situational Awareness	7: Preparation Planning Vigilance *This rating indicates the extent to which crews anticipate contingencies and actions that may be required. Excellent crews are always "ahead of the curve" while poor crews continually play catch up. Vigilant crews devote appropriate attention to required tasks and respond immediately to new information. A crew indulging in casual social conversation during periods of low workload is not necessarily lacking in vigilance if flight duties are being discharged properly.*	1) Actively monitors weather, aircraft systems, instruments and ATC communications, sharing relevant information with the rest of the crew.	1 2 3 4 5
		2) Avoids "tunnel vision", being aware of factors such as stress that can reduce vigilance - thus, monitoring the performance of other crewmembers.	1 2 3 4 5
		3) Verbally insures that cockpit and cabin crew are aware of plans.	1 2 3 4 5
		4) Climate, traffic and terrain are enduring components of the mental model.	1 2 3 4 5
		5) Information is prioritized consistent with the operational situation.	1 2 3 4 5
		6) Conflicts and "red flags" are quickly recognized and resolved.	1 2 3 4 5
		7) Crewmembers question status and programing of automation to verify and ensure situational awareness.	1 2 3 4 5
		8) Ensure that all crewmembers are aware of status and changes in automation parameters.	1 2 3 4 5

1	2	3	4	5
Poor Performance Significantly Below Expectations	Minimally Acceptable Performance Improvement Needed	Satisfactory or Standard Performance	Very Good, Above Average Performance	Exceptional Performance Significantly Above Standard

CREW PERFORMANCE MARKERS

Revision A (4/18/91)

CLUSTER	CATEGORY	MARKER	ASSESSMENT
C: **Workload Management and Situational Awareness**	8: **Workload Distribution/ Distractions Avoidance** *This is a rating of time and workload management. It reflects how well the crew managed to distribute the tasks and avoid overloading individuals. It also considers the ability of the crew to avoid being distracted from essential activities and how work is prioritized.*	1) Workload and time are managed to maximize efficiency.	1 2 3 4 5
		2) Workload is managed to maximize crew efficiency.	1 2 3 4 5
		3) Time is managed to optimize crew performance.	1 2 3 4 5
		4) Workload distribution is clearly communicated and acknowledged to maximize efficiency.	1 2 3 4 5
		5) Stays "ahead of curve" in preparing for expected or contingency situations (including approaches, weather, etc.	1 2 3 4 5
		6) Ensures that secondary operational tasks (i.e., dealing with passenger needs, company communications) are prioritized so as to allow sufficient resources for dealing effectively with primary flight duties.	1 2 3 4 5
		7) Recognizes and reports overloads in self and others.	1 2 3 4 5

1	2	3	4	5
Poor Performance Significantly Below Expectations	Minimally Acceptable Performance Improvement Needed	Satisfactory or Standard Performance	Very Good, Above Average Performance	Exceptional Performance Significantly Above Standard

CREW PERFORMANCE MARKERS

Revision A (4/18/91)

CLUSTER	CATEGORY	MARKER	ASSESSMENT
C: Workload Management and Situational Awareness	8: Workload Distribution/ Distractions Avoidance	8) Plans for sufficient time prior to maneuvers for programming of automation.	1 2 3 4 5
		9) Recognizes and deals with demands on resources posed by operation of automation.	1 2 3 4 5
		10) Reverts to lower levels of automation when programming demands could reduce situational awareness or create work overloads.	1 2 3 4 5
		11) Crewmembers recognize potential distractions posed by automation and take appropriate preventive action, including reverting to lower levels of automation.	1 2 3 4 5
		12) Activities are sequenced optimally.	1 2 3 4 5

1	2	3	4	5
Poor Performance Significantly Below Expectations	Minimally Acceptable Performance Improvement Needed	Satisfactory or Standard Performance	Very Good, Above Average Performance	Exceptional Performance Significantly Above Standard

CREW PERFORMANCE MARKERS

Revision A (4/18/91)

CLUSTER	CATEGORY	MARKER	ASSESSMENT
D: Operational Integrity	**1: Mission Completion and Risk Management** *Mission Completion and Risk Management is defined as the ability to complete the mission while minimizing risk and avoiding catastrophe.*	1) When confronted with an unusual event, evaluate options thoroughly without becoming commited to a single course of action with a high degree of risk. 2) Preformulate strategies to deal effectively with critical operational situations. 3) Consider desired vs. expected outcome. Project state or condition of aircraft to expected terminal condition and map this to desired condition.	1 2 3 4 5 1 2 3 4 5 1 2 3 4 5

1	2	3	4	5
Poor Performance Significantly Below Expectations	**Minimally Acceptable Performance Improvement Needed**	**Satisfactory or Standard Performance**	**Very Good, Above Average Performance**	**Exceptional Performance Significantly Above Standard**

CREW PERFORMANCE MARKERS

Revision A (4/18/91)

CLUSTER	CATEGORY	MARKER	ASSESSMENT
D: Operational Integrity	2: Regulatory Compliance *Regulatory Compliance involves the adherence to all pertinent operational regulations including FAR's, operational specifications, etc.*	1) Conscientious use of SOP's.	1 2 3 4 5
		2) Intentional non-compliance when this is judged to be the safest course of action.	1 2 3 4 5

1	2	3	4	5
Poor Performance Significantly Below Expectations	Minimally Acceptable Performance Improvement Needed	Satisfactory or Standard Performance	Very Good, Above Average Performance	Exceptional Performance Significantly Above Standard

CREW PERFORMANCE MARKERS

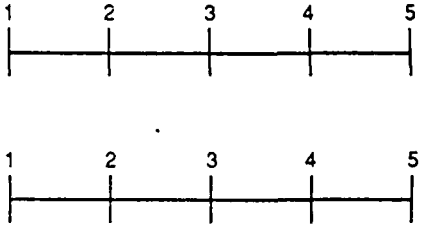
Revision A (4/18/91)

CLUSTER	CATEGORY	MARKER	ASSESSMENT
D: Operational Integrity	**3: Schedule Reliability** *Schedule Reliability involves considerations of operational integrity. Significant delays will impose schedule and economic penalties and must be considered during the conduct of the operation.*	1) Mission plan factors in destination arrival time.	1 2 3 4 5
		2) Enroute decisions factor in destination arrival time.	1 2 3 4 5
		3) Anticipated operational delays are communicated promptly.	1 2 3 4 5

1	2	3	4	5
Poor Performance Significantly Below Expectations	**Minimally Acceptable Performance Improvement Needed**	**Satisfactory or Standard Performance**	**Very Good, Above Average Performance**	**Exceptional Performance Significantly Above Standard**

CREW PERFORMANCE MARKERS

Revision A (4/18/91)

CLUSTER	CATEGORY	MARKER	ASSESSMENT
D: Operational Integrity	4: Operational Economy *Operational Economy involves considerations of efficient, economic flight operations performance. Fuel conservation is a significant component of economy.*	1) Enroute burn-out considered as part of all major planning decisions. 2) Approach speeds, flap settings and runway length are considered to minimize brake wear.	

1	2	3	4	5
Poor Performance Significantly Below Expectations	Minimally Acceptable Performance Improvement Needed	Satisfactory or Standard Performance	Very Good, Above Average Performance	Exceptional Performance Significantly Above Standard

CREW PERFORMANCE MARKERS "TECHNICAL"

Revision A (4/18/91)

CLUSTER	CATEGORY	MARKER	ASSESSMENT
E: Flight Maneuvers and Attitude Control	*Flight maneuvers involves precision manipulation of the velocity vector of the aircraft in time and space. Attitude control involves the maintenance of appropriate longitudinal and lateral transition and terminal positioning. Major focus here is on the "performance and control" aspects of flying.*	1) Instrument Interpretation: Properly interpret control, performance and AFDS indications.	1 2 3 4 5
		2) Instrument Selection: Select optimum displays and functions for specific mission tasks.	1 2 3 4 5
		3) Lateral Navigation: Predict and execute optimum course intercept, capture and track optimum course to achieve specific mission objective.	1 2 3 4 5
		4) Vertical Navigation: Monitor or control descent rate and/or path to achieve target vertical points. Maneuver aircraft to maintain optimum descent path and recognize status of the velocity vector.	1 2 3 4 5
		5) Attitude Control: Maintain optimum pitch attitude and bank angle control for appropriate flight conditions.	1 2 3 4 5
		6) Velocity Vector Control: Maintain optimum velocity vector control to achieve target vertical points.	1 2 3 4 5

1	2	3	4	5
Poor Performance Significantly Below Expectations	**Minimally Acceptable Performance Improvement Needed**	**Satisfactory or Standard Performance**	**Very Good, Above Average Performance**	**Exceptional Performance Significantly Above Standard**

CREW PERFORMANCE MARKERS "TECHNICAL"

Revision A (4/18/91)

CLUSTER	CATEGORY	MARKER	ASSESSMENT
E: Flight Maneuvers and Attitude Control	*Flight maneuvers involves precision manipulation of the velocity vector of the aircraft in time and space. Attitude control involves the maintenance of appropriate longitudinal and lateral transition and terminal positioning. Major focus here is on the "performance and control" aspects of flying.*	7) Trim Control: Maintain "in trim" condition to achieve a stable platform.	1 2 3 4 5
		8) Assess Aircraft State: Maintain position/terrain/obstacle awareness.	1 2 3 4 5
		9) Approach Stabilization: Achieve and maintain a stabilized final approach state. Considerations here include: a) Configuration management b) Speed management c) Glideslope control d) Power management e) Localizer/heading control f) In close line up, attitude and wings control.	1 2 3 4 5

1	2	3	4	5
Poor Performance Significantly Below Expectations	Minimally Acceptable Performance Improvement Needed	Satisfactory or Standard Performance	Very Good, Above Average Performance	Exceptional Performance Significantly Above Standard

CREW PERFORMANCE MARKERS "TECHNICAL"

Revision A (4/18/91)

CLUSTER	CATEGORY	MARKER	ASSESSMENT
F: Propulsion/Lift/Drag Control	*Propulsion, Lift and Drag Control involves achieving the optimum aircraft energy state to in turn achieve a specific mission objective.*	1) Instrument Interpretation: Proper and timely interpretation of key propulsion, lift and/or drag indications.	1 2 3 4 5
		2) Energy Management: Achieve and maintain target airspeed consistent with target altitudes and mission constraints. Optimum employment of aircrafts' acceleration/deceleration rates.	1 2 3 4 5
		3) Power Control: Smooth, precision application of power to achieve desired mission objectives.	1 2 3 4 5
		4) Lift Control: Optimize lift control systems to achieve desired mission objectives within known mission constraints.	1 2 3 4 5
		5) Drag Control: Manage aircraft platform and aerodynamic drag to achieve desired deceleration rates.	1 2 3 4 5

1	2	3	4	5
Poor Performance Significantly Below Expectations	**Minimally Acceptable Performance Improvement Needed**	**Satisfactory or Standard Performance**	**Very Good, Above Average Performance**	**Exceptional Performance Significantly Above Standard**

CREW PERFORMANCE MARKERS "TECHNICAL"

Revision A (4/18/91)

CLUSTER	CATEGORY	MARKER	ASSESSMENT
G: Systems Operations	*Systems operations involve the location and interpretation of controls and displays; the knowledge of operating concepts/limits; and the demonstrated use of operating procedures to accomplish specific mission objectives.*	1) Instrument Interpretation: Location of pertinent instruments and the interpretation of mission critical information.	1 2 3 4 5
		2) Operating Concepts: System operating concepts and functions that permit timely utilization of all system resources.	1 2 3 4 5
		3) Operating Limits: Limitations of system capabilities that may impact mission performance.	1 2 3 4 5
		4) Operating Procedures: Normal operating procedures that permit timely and effective utilization of all key system functions.	1 2 3 4 5

1	2	3	4	5
Poor Performance Significantly Below Expectations	**Minimally Acceptable Performance Improvement Needed**	**Satisfactory or Standard Performance**	**Very Good, Above Average Performance**	**Exceptional Performance Significantly Above Standard**

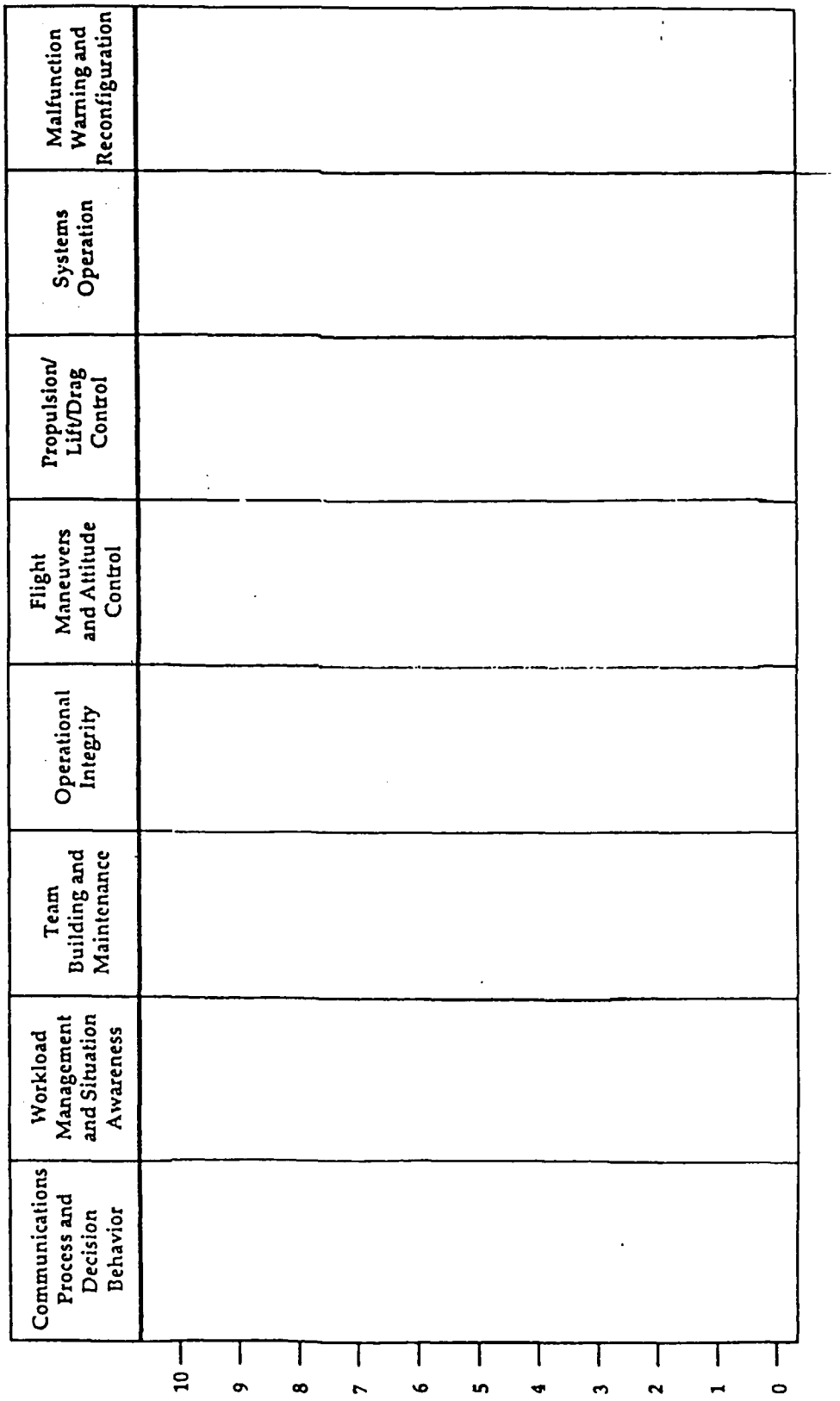
CREW PERFORMANCE MARKERS "TECHNICAL"

Revision A (4/18/91)

CLUSTER	CATEGORY	MARKER	ASSESSMENT
H: Malfunction Warning and Reconfiguration	*Malfunction warning involves assessing the information provided that indicates a degradation of system capability and/or integrity. System reconfiguration involves the means by which a system/aircraft is configured for continued safe flight after an abnormality* has occurred.	1) Instrument Interpretation: Assessment of mission critical information indication a system/aircraft degradation has occurred.	1 2 3 4 5
		2) Operating Concepts: System operating concepts that permit timely warnings of actual or impending system failures.	1 2 3 4 5
		3) Operating Procedures: System/aircraft reconfiguration procedures to ensure continued safe flight is possible.	1 2 3 4 5

1	2	3	4	5
Poor Performance Significantly Below Expectations	**Minimally Acceptable Performance Improvement Needed**	**Satisfactory or Standard Performance**	**Very Good, Above Average Performance**	**Exceptional Performance Significantly Above Standard**

INSTRUCTIONAL EMPHASIS



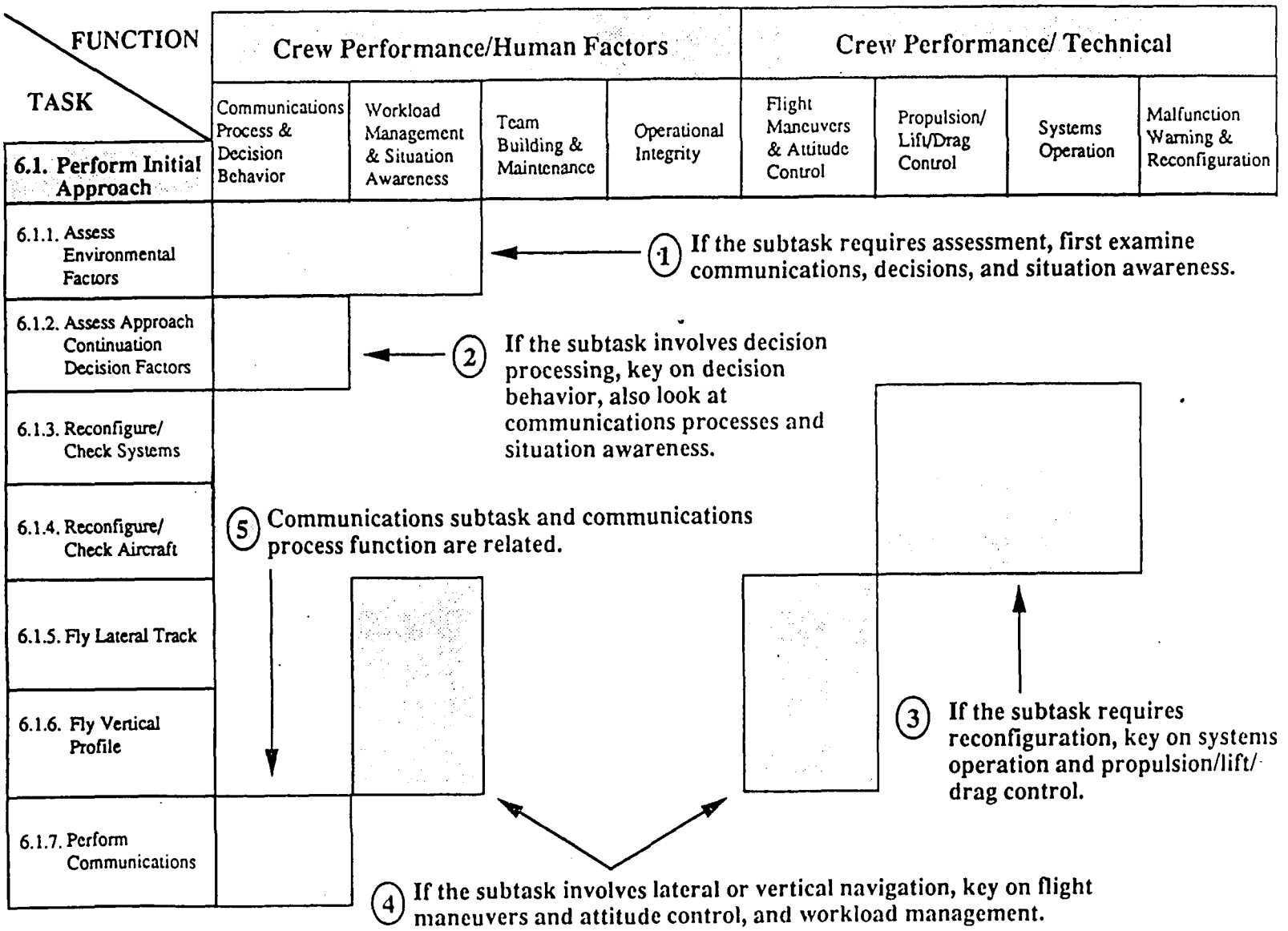
CRM INTEGRATION

FUNCTION / TASK	Crew Performance/Human Factors				Crew Performance/ Technical			
6.1. Perform Initial Approach	Communications Process & Decision Behavior	Workload Management & Situation Awareness	Team Building & Maintenance	Operational Integrity	Flight Manœuvers & Attitude Control	Propulsion/ Lift/Drag Control	Systems Operation	Malfunction Warning & Reconfiguration
6.1.1. Assess Environmental Factors								
6.1.2. Assess Approach Continuation Decision Factors								
6.1.3. Reconfigure/ Check Systems								
6.1.4. Reconfigure/ Check Aircraft								
6.1.5. Fly Lateral Track								
6.1.6. Fly Vertical Profile								
6.1.7. Perform Communications								

CRM INTEGRATION

FUNCTION / TASK	Crew Performance/Human Factors				Crew Performance/ Technical			
	Communications Process & Decision Behavior	Workload Management & Situation Awareness	Team Building & Maintenance	Operational Integrity	Flight Maneuvers & Attitude Control	Propulsion/ Lift/Drag Control	Systems Operation	Malfunction Warning & Reconfiguration
6.1. Perform Initial Approach								
6.1.1. Assess Environmental Factors								
6.1.2. Assess Approach Continuation Decision Factors								
6.1.3. Reconfigure/ Check Systems								
6.1.4. Reconfigure/ Check Aircraft								
6.1.5. Fly Lateral Track								
6.1.6. Fly Vertical Profile								
6.1.7. Perform Communications								

CRM INTEGRATION



CRM INTEGRATION

FUNCTION / TASK	Crew Performance/Human Factors				Crew Performance/ Technical			
	Communications Process & Decision Behavior	Workload Management & Situation Awareness	Team Building & Maintenance	Operational Integrity	Flight Maneuvers & Attitude Control	Propulsion/ Lift/Drag Control	Systems Operation	Malfunction Warning & Reconfiguration
6.1. Perform Initial Approach								
6.1.1. Assess Environmental Factors								
6.1.2. Assess Approach Continuation Decision Factors								
6.1.3. Reconfigure/ Check Systems								
6.1.4. Reconfigure/ Check Aircraft								
6.1.5. Fly Lateral Track								
6.1.6. Fly Vertical Profile								
6.1.7. Perform Communications								

CRM INTEGRATION

FUNCTION / TASK	Crew Performance/Human Factors				Crew Performance/ Technical			
	Communications Process & Decision Behavior	Workload Management & Situation Awareness	Team Building & Maintenance	Operational Integrity	Flight Maneuvers & Attitude Control	Propulsion/ Lift/Drag Control	Systems Operation	Malfunction Warning & Reconfiguration

I. NORMAL MISSION PROFILE

Note: An asterisk (*), which precedes any action statement in the following outlines denotes an item which is generic to all UA fleets. Items which are specific to the operation of the B-737-300/500 do not have an asterisk in front of the statement.

Note: To identify items which are repetitive, brackets containing outline paragraph numbers are placed after the action statement to identify the paragraph in the outline where the item first occurred. Example: [1.4.1.1.1]

1. * **PREFLIGHT GROUND OPERATIONS**
   - 1.1. * **Perform dispatch duties**
     - 1.1.1. * Assess environmental factors
       - 1.1.1.1. * Assess weather
       - 1.1.1.2. * Review terrain/obstacles
       - 1.1.1.3. * Discuss airport traffic
     - 1.1.2. * Review/assess operational factors
       - 1.1.2.1. * Review equipment operating factors
       - 1.1.2.2. * Review system operating factors
       - 1.1.2.3. * Assess/comply with operational legality
       - 1.1.2.4. * Determine aircraft gate location/flight status
       - 1.1.2.5. * Comply with reference info/guidance
     - 1.1.3. * Review/Assess aircraft maintenance status
       - 1.1.3.1. * Review log history
       - 1.1.3.2. * Review open items
       - 1.1.3.3. * Review deferred items
       - 1.1.3.4. * Comply with reference info/guidance
     - 1.1.4. * Perform flight planning duties
       - 1.1.4.1. * Review route/altitude
       - 1.1.4.2. * Perform fuel analysis
       - 1.1.4.3. * Perform weight analysis
       - 1.1.4.4. * File flight plan
       - 1.1.4.5. * Comply with reference info/guidance
     - 1.1.5. * Perform communications
       - 1.1.5.1. * Perform cockpit crew communications
       - 1.1.5.2. * Perform communications with company (dispatch)

1.1.5.3. * Perform communications with maintenance (Station/SAM)

1.2. * Perform preflight duties

1.2.1. * Monitor/Assess environmental factors
1.2.1.1. * Monitor/Assess weather
1.2.1.2. * Monitor/assess parking area congestion factors
1.2.2. * Perform preliminary cockpit setup
1.2.2.1. * Perform procedural flows
1.2.2.2. Comply with reference information/guidance
1.2.2.3. Enter FMC/IRS initial position
1.2.3. * Perform aircraft inspection
1.2.3.1. * Perform exterior inspection flow
1.2.3.2. * Perform interior inspection flow
1.2.4. * Perform cockpit preparation
1.2.4.1. * (F/O) Perform first officer procedural flows
1.2.4.2. (F/O) Comply with reference information/guidance (First Officer)
1.2.4.3. * (C) Perform captain procedural flows
1.2.4.4. (C) Comply with reference info/guidance (Captain)
1.2.5. * Perform before start preparations
1.2.5.1. * Perform procedural steps
1.2.5.2. Assess/Enter/Set FMC/MCP preflight data
1.2.5.3. Comply with reference info/guidance
1.2.5.4. * Perform before start checklist
1.2.6. * Perform communications
1.2.6.1. * Perform communications with ATC
1.2.6.2. * Perform cockpit crew communications
1.2.6.3. * Perform communications with cabin crew
1.2.6.4. * Perform communications with company (ramp)
1.2.6.5. * Perform communications with maintenance (sta)
1.2.6.6. * Perform communications with passengers
1.2.6.7. * Input/Receive ACARS data

1.3. * Perform start/pre-taxi

1.3.1. * Monitor/assess environmental factors
1.3.1.1. * Monitor weather
1.3.1.2. * Monitor airport traffic
1.3.1.3. * Monitor/assess position/obstacles
1.3.2. * Perform pushback

1.3.2.1. * Perform procedural flows/steps
1.3.2.2. * Comply with reference info/guidance
1.3.2.3. * Perform before pushback/taxi checklist
1.3.2.4. * Monitor pushback activities/progress
1.3.3. * Reconfigure/Check systems for pre-start
1.3.3.1. * Perform procedural steps
1.3.3.2. Comply with reference info/guidance
1.3.4. * Start engines
1.3.4.1. * Perform procedural steps
1.3.4.2. Comply with reference info/guidance
1.3.4.3. * Assess start abort decision factors
1.3.5. * Reconfigure/Check systems post start
1.3.5.1. * Perform procedural flows
1.3.5.2. Comply with reference info/guidance
1.3.5.3. * Perform after start checklist
1.3.6. * Reconfigure check aircraft
1.3.6.1. * Perform procedural steps
1.3.7. * Perform communications
1.3.7.1. * Perform communications with ATC
1.3.7.2. * Perform cockpit crew communications
1.3.7.3. * Perform communications with company (ramp)
1.3.7.4. * Perform communications with ground personnel

1.4. * Perform taxi

1.4.1. * Monitor/assess environmental factors
1.4.1.1. * Monitor/assess weather
1.4.1.2. * Monitor/maintain position/obstacle awareness
1.4.2. * Assess operational factors
1.4.2.1. * Assess/comply with takeoff legality
1.4.2.2. * Assess special performance takeoff requirements
1.4.2.3. * Assess/respond to mission delay factors
1.4.3. * Reconfigure/check systems
1.4.3.1. * Perform procedural flows/steps
1.4.3.2. Comply with reference info guidance
1.4.3.3. Assess/set/enter FMC/MCP data
1.4.3.4. * Perform before takeoff checklist (down to "line")
1.4.4. * Reconfigure/Check aircraft
1.4.4.1. * Perform procedural steps
1.4.4.2. Comply with reference info/guidance

1.4.5. * Maneuver aircraft
  1.4.5.1. * Perform thrust management
  1.4.5.2. * Perform brake management
  1.4.5.3. * Monitor/control directional steering
  1.4.5.4. Comply with reference info/guidance
1.4.6. * Perform airport navigation
  1.4.6.1. * Monitor airport ground traffic
  1.4.6.2. * Identify taxi route
  1.4.6.3. * Review/assess airport chart
  1.4.6.4. * Assess/comply with ATC instructions
1.4.7. * Perform Communications
  1.4.7.1. * Perform communication with ATC
  1.4.7.2. * Perform cockpit crew communication
  1.4.7.3. * Perform communication with cabin crew
  1.4.7.4. * Perform communication with company (ramp/dispatch)
  1.4.7.5. * Input/receive ACARS data

I. NORMAL MISSION PROFILE

2. * TAKEOFF OPERATIONS
   - 2.1. * **Perform Takeoff**
     - 2.1.1. * Monitor/assess environmental factors
       - 2.1.1.1. * Monitor/assess weather
       - 2.1.1.2. * Maintain position/terrain/obstacle awareness
       - 2.1.1.3. * Monitor/assess runway condition/status
     - 2.1.2. * Reconfigure/Check Systems
       - 2.1.2.1. * Perform procedural steps
       - 2.1.2.2. * Comply with reference info/guidance
       - 2.1.2.3. Assess/enter/set FMC/MCP data
       - 2.1.2.4. * Complete before takeoff checklist
     - 2.1.3. * Perform taxi on to runway
       - 2.1.3.1. * Perform thrust management
       - 2.1.3.2. * Perform brake management
       - 2.1.3.3. * Perform A/C change of control (if req)
       - 2.1.3.4. * Monitor adjust nose wheel steering
       - 2.1.3.5. * Align aircraft on runway centerline
     - 2.1.4. * Perform takeoff roll
       - 2.1.4.1. * Perform thrust management
       - 2.1.4.2. * Maintain runway alignment/directional control
       - 2.1.4.3. * Maintain traffic separation/avoidance
       - 2.1.4.4. * Comply with reference info/guidance
     - 2.1.5. * Monitor takeoff criteria
       - 2.1.5.1. * Monitor systems
       - 2.1.5.2. * Monitor external factors
       - 2.1.5.3. * Monitor aircraft performance
       - 2.1.5.4. * Monitor runway alignment/directional track
       - 2.1.5.5. * Comply with reference info/guidance
     - 2.1.6. * Perform rotation/liftoff
       - 2.1.6.1. * Establish takeoff attitude
       - 2.1.6.2. * Maintain runway alignment directional control
       - 2.1.6.3. * Comply with reference info/guidance
     - 2.1.7. Perform communications
       - 2.1.7.1. Perform communication with ATC

2.1.7.2. Perform cockpit crew communication

2.2. * Perform Rejected Takeoff

2.2.1. * Monitor/assess environmental factors
- 2.2.1.1. * Monitor/assess weather
- 2.2.1.2. * Maintain position/terrain/obstacle awareness
- 2.2.1.3. * Monitor/assess runway condition/status

2.2.2. * Assess abort decision factors
- 2.2.2.1. * Monitor/assess decision speeds
- 2.2.2.2. * Assess systems function/malfunctioning
- 2.2.2.3. * Assess aircraft controllability
- 2.2.2.4. * Comply with reference info/guidance

2.2.3. * Perform abort maneuver
- 2.2.3.1. * Perform brake management
- 2.2.3.2. * Monitor aircraft performance
- 2.2.3.3. * Maintain runway alignment directional control
- 2.2.3.4. * Perform thrust management
- 2.2.3.5. * Comply with reference info/guidance

2.2.4. * Monitor/check systems
- 2.2.4.1. * Monitor hydraulic systems
- 2.2.4.2. * Monitor electrical systems

2.2.5. * Reconfigure/check aircraft
- 2.2.5.1. * Perform procedural steps

2.2.6. * Perform post abort procedures
- 2.2.6.1. * Assess A/C condition
- 2.2.6.2. * Perform post landing procedural steps

2.2.7. * Monitor/assess evacuation criteria
- 2.2.7.1. * Assess A/C condition
- 2.2.7.2. * Assess ATC input
- 2.2.7.3. * Assess Flight Attendant input

2.2.8. Perform communications
- 2.2.8.1. * Perform communication with ATC
- 2.2.8.2. * Perform cockpit crew communication
- 2.2.8.3. * Perform communications with cabin crew
- 2.2.8.4. * Perform communications with company (ramp)
- 2.2.8.5. * Perform communications with maintenance (Sta)
- 2.2.8.6. * Perform communications with passengers

I. NORMAL MISSION PROFILE

3. * CLIMB OPERATIONS
   - **3.1. * Perform initial climb to 1000'**
     - 3.1.1. * Monitor/assess environmental factors
       - 3.1.1.1. * Monitor/assess weather
       - 3.1.1.2. * Maintain position/terrain obstacle awareness
     - 3.1.2. * Reconfigure/check aircraft
       - 3.1.2.1. * Perform procedural steps
       - 3.1.2.2. Comply with reference info/guidance
     - 3.1.3. * Fly/monitor/modify lateral track
       - 3.1.3.1. * Assess/comply with radar vectors
       - 3.1.3.2. * Perform published departure procedure
       - 3.1.3.3. Assess/enter/set MCP data
       - 3.1.3.4. * Maintain traffic separation/avoidance
       - 3.1.3.5. Comply with reference info/guidance
     - 3.1.4. * Fly/monitor/modify vertical profile
       - 3.1.4.1. * Monitor/control airspeed
       - 3.1.4.2. Assess/enter/set MCP data
       - 3.1.4.3. * Perform published departure procedure
       - 3.1.4.4. * Comply with reference info/guidance
     - 3.1.5. * Perform communications
       - 3.1.5.1. * Perform communications with ATC
       - 3.1.5.2. * Perform cockpit crew communication
       - 3.1.5.3. Comply with reference info/guidance
   - **3.2. * Perform climb to 3000'**
     - 3.2.1. * Monitor/assess environmental factors
       - 3.2.1.1. * Monitor/assess weather
       - 3.2.1.2. * Maintain position/terrain/obstacle awareness
     - 3.2.2. * Reconfigure/check aircraft
       - 3.2.2.1. * Perform procedural steps
       - 3.2.2.2. Comply with reference info/guidance
     - 3.2.3. * Reconfigure/check systems
       - 3.2.3.1. * Perform procedural flows
       - 3.2.3.2. Comply with reference info/guidance
     - 3.2.4. * Fly/monitor/modify lateral track

3.2.4.1. * Perform published departure procedure
3.2.4.2. * Perform course intercept tracking
3.2.4.3. * Assess/comply with radar vectors
3.2.4.4. Assess/enter/set MCP data
3.2.4.5. * Maintain traffic separation/avoidance
3.2.4.6. * Comply with reference info/guidance
3.2.5. * Fly/monitor/modify vertical profile
3.2.5.1. * Perform intermediate level offs
3.2.5.2. * Perform published departure procedure
3.2.5.3. * Monitor/modify climb rate
3.2.5.4. * Monitor/control airspeed
3.2.5.5. Assess/enter/set FMC/MCP data
3.2.5.6. * Comply with reference info/guidance
3.2.6. * Perform communications
3.2.6.1. * Perform communications with ATC
3.2.6.2. * Perform cockpit crew communications
3.2.6.3. Comply with reference info/guidance
3.3. * Perform secondary climb
3.3.1. * Monitor/assess environmental factors
3.3.1.1. * Monitor/assess weather
3.3.1.2. * Maintain position/terrain/obstacle awareness
3.3.2. * Reconfigure/check systems
3.3.2.1. * Perform procedural steps
3.3.2.2. Comply with reference info/guidance
3.3.2.3. * Perform after takeoff checklist
3.3.3. * Fly/monitor/modify lateral track
3.3.3.1. * Perform published departure procedure
3.3.3.2. * Perform course intercept tracking
3.3.3.3. * Assess/comply with radar vectors
3.3.3.4. Assess/enter/set FMC/MCP data
3.3.3.5. * Maintain traffic separation/avoidance
3.3.3.6. * Comply with reference info/guidance
3.3.4. * Fly/monitor/modify vertical profile
3.3.4.1. * Perform intermediate level offs
3.3.4.2. * Perform published departure procedure
3.3.4.3. * Monitor/modify climb rate

3.3.4.4. * Monitor/control airspeed
3.3.4.5. * Assess/set thrust
3.3.4.6. Assess/enter/set FMC/MCP data
3.3.4.7. * Comply with reference info/guidance
3.3.5. * Perform communications
3.3.5.1. * Perform communications with ATC
3.3.5.2. * Perform cockpit crew communications
3.3.5.3. Comply with reference info/guidance
3.3.5.4. * Perform communications with cabin crew
3.3.5.5. * Perform communications with passengers
3.3.5.6. * Input/receive ACARS data

I. NORMAL MISSION PROFILE

4. * CRUISE OPERATIONS
   - **4.1. * Perform enroute cruise**
     - 4.1.1. * Monitor/assess environmental factors
       - 4.1.1.1. * Monitor/assess weather
       - 4.1.1.2. * Maintain position/terrain awareness
       - 4.1.1.3. * Comply with reference info/guidance
     - 4.1.2. * Reconfigure/check/monitor systems
       - 4.1.2.1. * Perform periodic/continuing procedural steps
       - 4.1.2.2. * Comply with reference info/guidance
     - 4.1.3. * Fly/monitor/modify lateral track
       - 4.1.3.1. * Perform course intercept tracking
       - 4.1.3.2. * Assess/comply with radar vectors
       - 4.1.3.3. * Maintain traffic separation/avoidance
       - 4.1.3.4. Assess/enter/set FMC/MCP data
       - 4.1.3.5. Comply with reference info/guidance
     - 4.1.4. * Fly/monitor/modify vertical profile
       - 4.1.4.1. * Perform cruise climbs
       - 4.1.4.2. * Preform cruise descents
       - 4.1.4.3. * Monitor/control airspeed
       - 4.1.4.4. Assess/enter/set FMC/MCP data
       - 4.1.4.5. Comply with reference info/guidance
     - 4.1.5. * Analyze/optimize cruise parameters
       - 4.1.5.1. Assess FMC optimal cruise altitudes
       - 4.1.5.2. * Assess/set thrust
       - 4.1.5.3. * Assess alternate routings
       - 4.1.5.4. * Monitor/assess flight progress
       - 4.1.5.5. * Assess alternate altitudes
       - 4.1.5.6. * Comply with reference info/guidance
     - 4.1.6. * Perform routine duties
       - 4.1.6.1. * Record pertinent aircraft operational data
       - 4.1.6.2. * Comply with reference info/guidance
     - 4.1.7. * Perform communications
       - 4.1.7.1. * Perform communications with ATC
       - 4.1.7.2. * Perform cockpit crew communications

4.1.7.3. Comply with reference info/guidance
4.1.7.4. * Perform communications with cabin crew
4.1.7.5. * Perform communications with company (dispatch)
4.1.7.6. * Perform communications with maintenance (SAM)
4.1.7.7. * Perform communications with passengers
4.1.7.8. * Input/receive ACARS data

I. NORMAL MISSION PROFILE

5. * DESCENT/HOLDING
   - **5.1. * Perform initial descent from cruise altitude to FL 180**
     - 5.1.1. * Monitor/assess environmental factors
       - 5.1.1.1. * Monitor/assess weather
       - 5.1.1.2. * Maintain position/terrain awareness
     - 5.1.2. * Reconfigure/check systems
       - 5.1.2.1. * Perform pre-descent procedural steps
       - 5.1.2.2. * Perform descent procedural steps
       - 5.1.2.3. * Comply with reference info/guidance
     - 5.1.3. * Reconfigure/check aircraft
       - 5.1.3.1. * Perform procedural steps
     - 5.1.4. * Fly/monitor/modify lateral track
       - 5.1.4.1. * Perform published arrival/profile descent procedure
       - 5.1.4.2. * Perform course intercept tracking
       - 5.1.4.3. * Assess/comply with radar vectors
       - 5.1.4.4. Assess/enter/set FMC/MCP data
       - 5.1.4.5. * Maintain traffic separation/avoidance
       - 5.1.4.6. Comply with reference info/guidance
     - 5.1.5. * Fly/Monitor/modify vertical profile
       - 5.1.5.1. * Perform cruise descents
       - 5.1.5.2. * Preform intermediate leveloffs
       - 5.1.5.3. * Perform published arrival/profile descent procedure
       - 5.1.5.4. * Monitor/modify descent rate/path
       - 5.1.5.5. * Monitor/control airspeed
       - 5.1.5.6. Assess/enter/set FMC/MCP data
       - 5.1.5.7. Comply with reference info/guidance
     - 5.1.6. * Perform communications
       - 5.1.6.1. * Perform communications with ATC
       - 5.1.6.2. * Perform cockpit crew communications
       - 5.1.6.3. * Comply with reference info/guidance
       - 5.1.6.4. * Perform communications with cabin crew
       - 5.1.6.5. * Perform communications with company (dispatch/ramp)
       - 5.1.6.6. * Perform communications with passengers
       - 5.1.6.7. * Input/receive ACARS data

5.2. * Perform approach descent from FL180 to approach
- 5.2.1. * Monitor/assess environmental factors
  - 5.2.1.1. * Monitor/assess weather
  - 5.2.1.2. * Maintain position/terrain/obstacle awareness
- 5.2.2. * Reconfigure/check systems
  - 5.2.2.1. * Perform procedural steps
  - 5.2.2.2. * Comply with reference info/guidance
  - 5.2.2.3. * Perform approach/descent checklist
- 5.2.3. * Reconfigure/check aircraft
  - 5.2.3.1. * Perform procedural steps
- 5.2.4. * Fly/monitor/modify lateral track
  - 5.2.4.1. * Perform published arrival/profile descent procedure (prior to IAF)
  - 5.2.4.2. * Perform course intercept tracking
  - 5.2.4.3. * Assess/comply with radar vectors
  - 5.2.4.4. Assess/enter/set FMC/MCP data
  - 5.2.4.5. * Maintain traffic separation/avoidance
  - 5.2.4.6. * Comply with reference info/guidance
- 5.2.5. * Fly/Monitor/modify vertical profile
  - 5.2.5.1. * Perform approach descents
  - 5.2.5.2. * Preform intermediate leveloffs
  - 5.2.5.3. * Perform published arrival/profile descent procedure (prior to IAF)
  - 5.2.5.4. * Monitor/modify descent rate/path
  - 5.2.5.5. * Monitor/control airspeed
  - 5.2.5.6. Assess/enter/set FMC/MCP data
  - 5.2.5.7. Comply with reference info/guidance
- 5.2.6. * Perform communications
  - 5.2.6.1. * Perform communications with ATC
  - 5.2.6.2. * Perform cockpit crew communications
  - 5.2.6.3. Comply with reference info/guidance
  - 5.2.6.4. * Perform communications with cabin crew
  - 5.2.6.5. * Perform communications with company (ramp)
  - 5.2.6.6. * Perform communications with passengers
  - 5.2.6.7. * Input/receive ACARS data
  - 5.2.6.8. * Comply with reference info/guidance

5.3. * Perform holding
- 5.3.1. * Monitor/assess environmental factors

5.3.1.1. * Monitor/assess weather
5.3.1.2. * Maintain position/terrain/obstacle awareness
5.3.2. * Assess divert decision factors
5.3.3. * Fly/Monitor/modify lateral track
5.3.4. * Fly/Monitor/modify vertical profile
5.3.5. * Perform communications

I. NORMAL MISSION PROFILE

6. * APPROACH OPERATIONS

Note: The following designations are used to distinguish which items in the task listing are specific to a particular type of instrument approach. This is done so that all approaches can be shown in a single listing instead of making a separate listing for each individual approach.

I = Category I ILS/ILS-DME
II = Category II ILS/ILS-DME
III = Category IIIA/IIIB ILS/ILS-DME
LO = LOC/LOC-DME
BC = LOC Back Course
LD = LDA/LDA-DME
VO = VOR/VOR-DME
N = NDB/NDB-DME
S = SDF
A = ASR
V = Visual Approach
C = Contact Approach

If no designation is shown for an action statement, then that item is applicable to all approach types.

6.1. * Perform initial approach (Outside FAF and/or prior to final course intercept)

6.1.1. * Monitor/assess environmental factors
6.1.1.1. * Monitor/assess weather
6.1.1.2. * Maintain position/terrain/obstacle awareness
6.1.1.3. * Comply with reference info/guidance
6.1.2. * Assess approach continuation decision factors
6.1.2.1. * Monitor/assess weather criteria
6.1.2.2. * Monitor/assess operational factors
6.1.2.3. * Monitor/assess aircraft status
6.1.2.4. * Comply with reference info/guidance
6.1.3. * Reconfigure/check systems
6.1.3.1. * Perform procedural steps
6.1.3.2. Comply with reference info/guidance
6.1.4. * Reconfigure/check aircraft
6.1.4.1. * Perform procedural steps

6.1.4.2. * Perform final descent checklist
6.1.4.3. Comply with reference info/guidance
6.1.5. * Fly/monitor/modify lateral track
6.1.5.1. * Determine position relative to IAF/FAF/procedural course
6.1.5.2. * Perform published approach procedure
6.1.5.3. * Monitor/Perform course intercept tracking
6.1.5.4. * Assess/comply with radar vectors
6.1.5.5. Assess/enter/set FMC/MCP data
6.1.5.6. Assess AFDS requirements
6.1.5.7. * Maintain traffic separation/avoidance
6.1.5.8. * Comply with reference info/guidance
6.1.6. * Fly/Monitor/modify vertical profile
6.1.6.1. * Perform published approach procedure
6.1.6.2. * Monitor/control descent rate/path
6.1.6.3. * Monitor/control airspeed
6.1.6.4. Assess AFDS requirements
6.1.6.5. Comply with reference info/guidance
6.1.6.6. Assess/enter/set FMC/MCP data
6.1.7. * Perform communications
6.1.7.1. * Perform communications with ATC
6.1.7.2. * Perform cockpit crew communications
6.1.7.3. Comply with reference info/guidance
6.1.7.4. * Perform communications with cabin crew
6.1.7.5. * Perform communications with passengers
6.1.7.6. Comply with reference info/guidance

6.2. * Perform final approach (after final course intercept and/or inside FAF)

6.2.1. * Monitor/assess environmental factors
6.2.1.1. * Monitor/assess weather
6.2.1.2. * Maintain position/terrain/obstacle awareness
6.2.2. * Assess continuation/missed approach decision factors (on final approach)
6.2.2.1. * Assess weather criteria
6.2.2.2. * Monitor/assess operational factors
6.2.2.3. * Monitor/assess aircraft status
6.2.2.4. * Comply with reference info/guidance
6.2.3. * Reconfigure/check systems
6.2.3.1. * Perform procedural steps

6.2.3.2. Comply with reference info/guidance
6.2.4. * Reconfigure/check aircraft
6.2.4.1. * Perform procedural steps
6.2.4.2. Comply with reference info/guidance
6.2.5. * Fly/Monitor/modify lateral track
6.2.5.1. * Determine position relative to procedural course/MAP
6.2.5.2. Perform published approach procedure
6.2.5.3. * * Monitor/Perform course tracking
6.2.5.4. * Assess/comply with radar vectors
6.2.5.5. Assess/enter/set FMC/MCP data
6.2.5.6. Assess AFDS requirements
6.2.5.7. * Maintain traffic separation/avoidance
6.2.5.8. Comply with reference info/guidance
6.2.6. * Fly/Monitor/modify vertical profile
6.2.6.1. * Perform published approach procedure
6.2.6.2. * Monitor/control descent rate/path
6.2.6.3. * Monitor/control airspeed
6.2.6.4. Assess AFDS requirements
6.2.6.5. Assess/enter/set FMC/MCP data
6.2.6.6. Comply with reference info/guidance
6.2.7. * Perform transition to landing/monitor stabilization/landing cues
6.2.7.1. * Perform transfer of control (if req) (II, III)
6.2.7.2. * Monitor/assess weather criteria
6.2.7.3. * Monitor/assess operational factors
6.2.7.4. * Comply with reference info/guidance
6.2.8. * Perform communications
6.2.8.1. * Perform communications with ATC
6.2.8.2. * Perform cockpit crew communications
6.2.8.3. * Comply with reference info/guidance

I. NORMAL MISSION PROFILE

7. * LANDING OPERATIONS
   - 7.1. * Landing
     - 7.1.1. * Monitor/assess environmental factors
       - 7.1.1.1. * Monitor/assess weather
       - 7.1.1.2. * Maintain position/terrain/obstacle awareness
       - 7.1.1.3. * Monitor/assess runway condition/status
     - 7.1.2. * Reconfigure/check systems
       - 7.1.2.1. * Perform procedural steps
       - 7.1.2.2. Comply with reference info/guidance
       - 7.1.2.3. * Monitor hydraulic systems
     - 7.1.3. * Reconfigure/check aircraft
       - 7.1.3.1. * Perform procedural steps
       - 7.1.3.2. Comply with reference info/guidance
     - 7.1.4. * Perform landing maneuver
       - 7.1.4.1. * Assess/adjust touchdown point
       - 7.1.4.2. * Perform flare/touchdown maneuver
       - 7.1.4.3. * Maintain runway centerline alignment/track
       - 7.1.4.4. * Perform thrust management
       - 7.1.4.5. Comply with reference info/guidance
     - 7.1.5. * Perform landing roll out maneuver
       - 7.1.5.1. * Perform post touchdown flight control inputs
       - 7.1.5.2. * Perform thrust management
       - 7.1.5.3. * Perform brake management
       - 7.1.5.4. * Monitor aircraft performance
       - 7.1.5.5. * Maintain runway alignment/directional control
       - 7.1.5.6. * Perform transfer of control (if app)
       - 7.1.5.7. * Comply with reference info/guidance
     - 7.1.6. * Perform runway exit maneuver
       - 7.1.6.1. * Perform thrust management
       - 7.1.6.2. * Perform brake management
       - 7.1.6.3. * Monitor/adjust nosewheel steering
     - 7.1.7. * Perform communications
       - 7.1.7.1. * Perform communications with ATC
       - 7.1.7.2. * Perform cockpit crew communications

7.2. * **Perform rejected landing**
- 7.2.1. * Monitor/assess environmental factors
  - 7.2.1.1. * Monitor/assess weather
  - 7.2.1.2. * Maintain position/terrain/obstacle awareness
- 7.2.2. * Assess go around decision factors
  - 7.2.2.1. * Monitor/assess weather criteria
  - 7.2.2.2. * Monitor/assess operational factors
  - 7.2.2.3. * Monitor/assess aircraft status
- 7.2.3. * Reconfigure/check systems
  - 7.2.3.1. * Perform procedural steps
  - 7.2.3.2. Comply with reference info/guidance
  - 7.2.3.3. * Perform after takeoff checklist
- 7.2.4. * Reconfigure/check aircraft
  - 7.2.4.1. * Perform procedural steps
- 7.2.5. * Fly/Monitor/modify lateral track
  - 7.2.5.1. * Perform course intercept tracking
  - 7.2.5.2. * Assess/comply with radar vectors
  - 7.2.5.3. * Perform published missed approach procedure
  - 7.2.5.4. Assess/enter/set MCP data
  - 7.2.5.5. * Maintain traffic separation/avoidance
  - 7.2.5.6. * Comply with reference info/guidance
- 7.2.6. * Fly/Monitor/modify vertical profile
  - 7.2.6.1. Establish/modify target pitch attitudes
  - 7.2.6.2. * Monitor/control airspeed
  - 7.2.6.3. * Monitor/modify climb rate
  - 7.2.6.4. Assess/enter/set MCP data
  - 7.2.6.5. * Perform published missed approach procedure
  - 7.2.6.6. Monitor/respond to autopilot engagement mode effects
  - 7.2.6.7. Comply with reference info/guidance
- 7.2.7. * Perform communications
  - 7.2.7.1. * Perform communications with ATC
  - 7.2.7.2. * Perform cockpit crew communications
  - 7.2.7.3. * Perform communications with cabin crew
  - 7.2.7.4. * Perform communications with company (dispatch, if req)
  - 7.2.7.5. * Perform communications with passengers
  - 7.2.7.6. * Input/receive ACARS data

I. NORMAL MISSION PROFILE

8. * POST FLIGHT GROUND OPERATIONS
   - 8.1. * **Perform taxi**
     - 8.1.1. * Monitor/assess environmental factors
       - 8.1.1.1. * Monitor/assess weather
       - 8.1.1.2. * Maintain position/terrain/obstacle awareness
       - 8.1.1.3. * Monitor/assess taxiway/ramp condition/suitability
     - 8.1.2. * Reconfigure/check systems
       - 8.1.2.1. * Perform procedural flows
       - 8.1.2.2. Comply with reference info/guidance
     - 8.1.3. * Reconfigure/check aircraft
       - 8.1.3.1. * Perform procedural flows
       - 8.1.3.2. * Comply with reference info/guidance
     - 8.1.4. * Maneuver aircraft
       - 8.1.4.1. * Perform thrust management
       - 8.1.4.2. * Perform brake management
       - 8.1.4.3. * Monitor/control directional steering
       - 8.1.4.4. * Comply with reference info/guidance
     - 8.1.5. * Perform airport navigation
       - 8.1.5.1. vMonitor airport ground traffic
       - 8.1.5.2. * Identify taxi route
       - 8.1.5.3. Review/assess airport chart
       - 8.1.5.4. * Assess/comply with ATC instructions
     - 8.1.6. * Perform Communications
       - 8.1.6.1. * Perform communications with ATC
       - 8.1.6.2. * Perform cockpit crew communications
       - 8.1.6.3. * Perform communications with cabin crew
       - 8.1.6.4. * Perform communications with company (ramp)
       - 8.1.6.5. * Perform communications with passengers
       - 8.1.6.6. * Input/receive ACARS data
   - 8.2. * **Perform parking**
     - 8.2.1. * Monitor/assess environmental factors
       - 8.2.1.1. * Monitor/assess weather
       - 8.2.1.2. * Maintain position/obstacle awareness
       - 8.2.1.3. * Monitor/assess parking area condition/suitability

8.2.1.4.
8.2.2. * Reconfigure/check systems
8.2.2.1. * Perform procedural steps
8.2.2.2. Comply with reference info/guidance
8.2.3. * Maneuver aircraft
8.2.3.1. * Perform thrust management
8.2.3.2. * Perform brake management
8.2.3.3. * Monitor/control directional steering
8.2.3.4. * Align/stop aircraft
8.2.3.5. * Comply with reference info/guidance
8.2.4. * * * * Perform communications
8.2.4.1. Perform cockpit crew communication

8.3. * Perform shutdown

8.3.1. * * Reconfigure/check systems
8.3.1.1. Perform normal shutdown procedural flows
8.3.1.2. * Perform "terminating flight" procedural flows
8.3.1.3. Comply with reference info/guidance
8.3.1.4. * Perform parking checklist
8.3.2. * Perform communications
8.3.2.1. * Perform cockpit crew communications

8.4. * Perform post shutdown

8.4.1. * Perform routine duties
8.4.1.1. * Monitor/assess aircraft systems status
8.4.1.2. * Record pertinent aircraft operational data
8.4.2. * Perform communications
8.4.2.1. * Perform cockpit crew communication
8.4.2.2. * Perform communications with cabin
8.4.2.3. * Perform communications with company (dispatch/ramp)
8.4.2.4. * Perform communications with maintenance (station/SAM)
8.4.2.5. * Perform communications with passengers
8.4.2.6. * Perform communications with passenger service agent
8.4.2.7. Input/receive ACARS data

TASK ANALYSIS STRUCTURING

The following are definitions of different levels of the task analysis structure used by United Airlines in their AQP application. As much as possible, United Airlines attempts to conform to this guideline when assigning individual action statements from a job inventory to different levels of the task analysis.

PHASE:

Phase of flight (ground operations, takeoff, etc.), organized in sequence. (Note: no action verb required.)

PROCEDURE:

General subset of phase, typically sequential or chronological, i.e.:

1) Climb to 1000'.
2) Climb to 3000'.
3) Secondary climb, etc.

(Note: action verb required.)

TASK:

Sets of "action groups" which are non-sequential, not necessarily related, all of which must be accomplished to some degree to successfully perform the parent procedure, i.e.:

1) Perform communications.
2) Reconfigure/check aircraft.
3) Fly/monitor/modify lateral track, etc.

(Note: action verb required.)

SUBTASK:

Specific subset of non-sequential, potentially related "action groups" any or all of which may need to be accomplished to successfully complete the parent task. Some subtasks may be optional or may be performed to the exclusion of another subtask listed under the same parent task, i.e.:

1) Perform course intercept/tracking.
2) Assess/comply with radar vectors.
3) Maintain traffic separation/avoidance.

(Note: action verb required.)

ELEMENT:

Specific set of discrete or grouped actions or non-action inventory list items which may be a breakdown of a subtask single action statement. An element usually specifies a discrete activity or sets of related or non-related discrete activities to support the subtask action

group. Typical examples are a statement of a single switch movement or a statement of positioning of a switch group with individual switch names inventoried in the sub-element group. Other element level activities may include cognitive functions such as monitor, consider or determine certain items which may affect the accomplishment of the subtask, i.e.:

1) Set crossfeed switch.
2) Set fuel pump switches:
   - main pumps
   - center tank pumps
3) Determine crew duties.
4) Assess conflicting traffic inputs:
   - visual
   - ATC
   - other Aircraft
   - TCAS.

(Note: Action verb may be required.)

SUPPLEMENT:

sets of related non-sequential inventoried items which are supporting lists to action statements of the element level. May include action statement, but only on the very lowest performance level, i.e.:

1) Determine crew duties (element)
   - aircraft control (sub-element)
   - checklist accomplishment
   - communication assignments

APPENDIX E:

Synopsis of Jan Demuth's Comments

SYNOPSIS OF JAN DEMUTH'S COMMENTS

21 November 1991 - Integrated CRM Workshop

These remarks were made in the context of organizational culture and support for CRM. The main points follow.

(1) CRM skills and technical skills can be and should integrated--at least in the teaching mode.

(2) At this point in time, and with the revised CRM advisory, we have some common language and a start-point exists.

(3) The revised CRM advisory is a bench mark for where we (FAA) are now--and, the revision also reflects that industry was long past the "old" CRM advisory being useful.

(4) The interchange, communication and cooperation between FAA, industry and academe which has occurred due to the ATA subcommittee and working group--and, in the drafting of the revisions to the CRM advisory--is of a high level. Our hope is that this cooperation and involvement will continue.

(5) While no airline *must* use anything in the revised advisory, we hope the common language and cooperative efforts that led to this revision will facilitate the airlines in using the advisory as they see fit.

Mr. Demuth then re-addressed a hot issue at the workshop: CRM Evaluation. He again said that CRM is not being used by the FAA for qualification and certification issues. When/if the evaluation issues can be resolved, the rule will be made--a rule based on what has been learned, what *can* be done and validated as to CRM evaluation. He also re-made the distinction between mandatory CRM and mandating its evaluation. He did indicate the industry must look at Integrated CRM Evaluation as it will come about.

APPENDIX F:

Results of Survey Forms

Participant Data Sheet (Phase I - APPENDIX C)

Unless otherwise noted, all figures are averages of participants' responses.

LENGTH OF TIME WITH CURRENT ORGANIZATION: 13.44 years

PILOT *(sum)*: Y 8 N 2 CURRENTLY LICENSED *(sum)*: Y 8 N ___

TYPE OF LICENSE *(sum)*: 8 ATPs

AIRCRAFT QUALIFIED IN *(list & [number of pilots])*: Average = 3.38 types per pilot.

B-52 [1]	B-1900 [1]	DC-3 [1]
EB-66 [1]	C-130 [1]	DC-6 [1]
FB-111 [1]	KC-135 [1]	DC-7 [1]
B-707 [1]	C-141 [1]	DC-8 [1]
B-727 [3]	CL-600 [1]	DC-9 [4]
B-737 [2]	Conv 240/340/440 [1]	DC-10 [1]
B747-400 [1]	Lear [1]	MD-80 [2]
B757/767 [3]	Sabreliner 65 [1]	T-39 [1]

HAVE EXPERIENCE IN:	*(count)*	*(average)*
. Operational Analysis	Y 7	Length of Time 9.33 years
. Organizational Analysis		Y 5 Length of Time 3.44 years
. ISD	Y 5	Length of Time 5.11 years
. Human Factors	Y 8	Length of Time 6.5 years
. Aviation Psychology	Y 6	Length of Time 5.22 years

PRE-WORKSHOP SURVEY

(Averages)

1. My skills in analyzing and evaluating put me about here, relative to the others.

Very highly skilled						No skill at all	
1	2	***3***	4	5	6	7	3.3

2. I think my ideas will be, in essence, in agreement with the rest of the participants.

Yes, absolutely						No, not at all	
1	2	***3***	4	5	6	7	3.0

3. I know most of the participants very well.

Yes, pretty much						No, none at all	
1	2	3	4	***5***	6	7	4.7

4. I have some definite ideas about what skills are necessary for aviation mission success.

Yes, lots						No, none	
1	***2***	3	4	5	6	7	2.1

5. I have extensive experience in aviation operations analysis.

Yes						No	
1	2	3	***4***	5	6	7	3.6

6. I have extensive experience in training and evaluating aviators.

Yes						No	
1	***2***	3	4	5	6	7	2.0

7. I am anticipating that the workshop is going to be achieving our objectives.

Yes, I think it will be						No, I think it may be a waste of time	
1	***2***	3	4	5	6	7	2.1

POST WORKSHOP SURVEY

(Averages)

1. I feel very satisfied with the results.	1 2 ***3*** 4 5 6 7 *2.7*	I'm not satisfied with the results, at all.
2. I learned from the feedback.	1 ***2*** 3 4 5 6 7 *1.5*	I didn't learn a thing from the feedback.
3. In general, I agreed with the ideas in the feedback.	1 ***2*** 3 4 5 6 7 *1.8*	I disagreed with everything in the feedback.
4. I felt that I could express my ideas well.	1 ***2*** 3 4 5 6 7 *1.5*	I couldn't really say what I wanted to say.
5. I felt as if I really wanted to talk or interact.	1 ***2*** 3 4 5 6 7 *2.0*	I didn't feel the need to talk or interact at all.
6. I have a feeling the participants didn't understand or think about my reasons.	1 2 3 4 5 ***6*** 7 *6.0*	I think the participants understood my reasons pretty well.
7. I think the workshop went too quickly; we needed more time.	1 2 3 ***4*** 5 6 7 *3.8*	I think the workshop went too slowly; we could've accomplished the objectives with much less time.

GROUP PROCESSES SURVEY

(Averages)

A. How clear are the group goals? *3.5*

1. No apparent goals ___
2. Goal confusion, uncertainty, or conflict ___
3. Average goal clarity ___
4. Goals mostly clear ___
5. Goals very clear ___

B. How much trust and openness in the group? *4.3*

1. Distrust, a closed group ___
2. Little trust, defensiveness ___
3. Average trust and openness ___
4. Considerable trust and openness ___
5. Remarkable trust and openness ___

C. How sensitive and perceptive are group members? *4.2*

1. No awareness or listening in the group ___
2. Most members self-absorbed ___
3. Average sensitivity and listening ___
4. Better than usual listening ___
5. Outstanding sensitivity to others ___

D. How much attention was paid to process (the way the group was working)? *3.3*

1. No attention to process ___
2. Little attention to process ___
3. Some concern with group process ___
4. A fair balance between content and process ___
5. Very concerned with process ___

E. How were group leadership needs met? *4.5*

1. Not met, drifting ___
2. Leadership concentrated in one person ___
3. Some leadership sharing ___
4. Leadership functions distributed ___
5. Leadership needs met creatively and flexibly ___

F. How were group decisions made? *4.3*

1. No decisions could be reached ___
2. Made by a few ___
3. Majority vote ___
4. Attempts at integrating minority vote ___
5. Full participation and tested consensus ___

G. How well were group resources used? *4.0*

1. One or two contributed, but most were silent ___
2. Several tried to contribute, but were discouraged ___
3. Average use of group resources ___
4. Group resources well used and encouraged ___
5. Group resources fully and effectively used ___

H. How much loyalty and sense of belonging to the group? *4.2*

1. Members had no group loyalty or sense of belonging ___
2. Members not close, but some friendly relations ___
3. About average sense of belonging ___
4. Some warm sense of belonging ___
5. Strong sense of belonging among members ___